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DRAFT
SAMPLING AND ANALYSIS PLAN
FOR
RICHARDSON FLAT

Site ID Number : UT980952840

October 24, 2000

Prepared for:

United Park City Mines Company
P.O. Box 1450
Park City, UT 84060

Prepared by:

Environmental Resource Management Consultants d.b.a. RMC
8138 South State Street, Suite 2A
Midvale, Utah 84047

Phone: (801) 255-2626
Fax: (801) 255-3266

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Prepared by: _____ Date: _____
Jim Fricke
Resource Management Consultants

Reviewed by: _____ Date: _____
Kerry Gee
United Park City Mines Company

Reviewed by: _____ Date: _____
Jim Christiansen
USEPS Remedial Project Manager

TABLE OF CONTENTS

Figures

Tables

Appendices

1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) addresses the sampling and analysis of surface and ground water, soils, sediment and tailings materials during field activities conducted as part of a focused Remedial Investigation and Feasibility Study (RI/FS) at the Richardson Flat Tailings site (Site) near Park City, Utah. The Site is an inactive mill tailings impoundment owned by United Park City Mines Company (United Park), United Park is conducting the RI/FS pursuant to the Administrative Order on Consent For focused Remedial Investigation/Feasibility Study, dated September 28, 2000, U.S. EPA Docket No. [**CERCLA-8-2000-19**] (AOC). The RI/FS Workplan (RMC, 2000) as referenced in this SAP was approved by the United States Environmental Protection Agency Region VIII (EPA) on September 28, 2000.

This SAP combines the relevant portions of a Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP). As requested by EPA, the format of this plan follows the 16 elements of a QAPP as defined in *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (USEPA QA/R-5, 1998a). Section titles are followed by the corresponding QA/R-5 outline numbers in parentheses.

The SAP contains the Health & Safety Plan (HASP) that will be followed during Site activities by all visitors. (*See* Appendix A)

This SAP, when necessary, can and may be amended should there be a need to do so. It will also provide procedures for sampling to be conducted as part of EPA oversight of the RI/FS.

2.0 PROJECT MANAGEMENT (A)

2.1 Project/Task Organization (A4)

The RI/FS management team consists of United Park personnel with assistance from Resource Management Consultants (RMC) and other environmental consulting firms as needed. Figure 1 shows the chain-of-command for the project managers, engineers, and quality assurance officials responsible for managing the Richardson Flat Tailings Site RI/FS.

United Park's environmental Project Manager for the Site is Kerry Gee, who will be responsible for all project management and communication with the regulatory agencies. Jim Fricke of RMC, Salt Lake City, Utah, leads United Park's environmental project consultant team and will be the Site Manager, who will be responsible for implementation of the SAP. Todd Leeds, RMC, is the Field Manger who will be responsible for all field activities related to this document. Darlene Batatian, RMC, is the Site Safety Officer, who will be responsible for visitor sign in and ensure that all site visitors comply with the HASP.

The EPA Project Coordinator is Jim Christiansen, Region VIII, Denver, Colorado. The Utah Department of Environmental Remediation and Response (UDERR) Project Manager is Steven Thiriot.

Mr. Gee, as Project Manager, is responsible for the overall management and coordination of the following activities:

- Coordination with EPA/UDERR regarding the status of the project;
- Providing oversight of the subcontractors;
- Reviewing monthly status reports;
- Supervising production and review of deliverables;
- Tracking work progress against planned budgets and schedules;
- Informing EPA/UDERR of changes in the Workplan, SAP, HASP and/or other project documents;

- Notifying EPA/UDERR immediately of significant problems affecting the quality of data or the ability to meet project objectives;
- Procuring subcontractors to provide sampling and analytical support;
- Providing oversight of report preparation;
- Organizing and conducting a field planning meeting.

Mr. Fricke, as the Site Manager, is responsible for the following:

- Preparing monthly status reports;
- Coordinating with the laboratory regarding the analytical, data validation, and Quality Assurance/Quality Control (QA/QC) issues related to sample analysis;
- Reviewing analytical results and deliverables from subcontractors;
- Incorporating changes in the Workplan, SAP, HASP, and/or other project documents;
- Scheduling personnel and material resources;
- Implementing field aspects of the investigation, including this SAP and other project documents;
- Implementing the QC measures specified in the QAPP in this and other project documents;
- Implementing corrective actions resulting from staff observations, QA/QC surveillance, and /or QA audits;
- Providing oversight of data management;
- Coordinating and overseeing the efforts of the subcontractors providing sampling and analytical support;
- Scheduling and conducting field work;
- Notifying the subcontract analytical laboratory of scheduled sample shipments and coordinating work activities;
- Gather sampling equipment and field logbooks and confirming required sample containers and preservatives.
- Maintaining proper chain-of-custody forms and shipping of samples to the analytical laboratory during sampling events;

- Ensuring that sampling is conducted in accordance with procedures detailed in this SAP and that the quantity and location of all samples meet the requirements of the SAP; and
- Identifying problems at the field team level; resolving difficulties in consultation with the QA/QC staff; implementing and documenting corrective action procedures at the field team level; and providing communication between the field team and United Park management.

The roles and responsibilities of other field team members will be to assist the Site Manager with sampling activities, sample handling, and overall documentation.

Oversight activities including sampling to be conducted by EPA's on-site contractor will be coordinated between the EPA Project Coordinator and United Park's Project Manager. EPA's on-site contractor and the Site or Field manager will work together to coordinate sampling efforts.

2.1.2 Quality Assurance/Quality Control Organization

The Quality Assurance Official (QAO) is Gary Colgan, with Aquifer Science, who is responsible for the quality assurance/quality control of the data that are generated during implementation of the SAP. Mr. Colgan will report any QA/QC problems to the Site Manager. As the QAO, he will be responsible for the following:

- Reviewing and approving project specific plans;
- Directing the overall project QA/QC program;
- Maintaining QA/QC oversight of the project;
- Reviewing QA/QC sections in project reports, as applicable;
- Reviewing QA/QC procedures applicable to this SAP;
- Auditing selected activities of this project performed by RMC and subcontractors, as necessary;

- Initiating, reviewing, and following up on response actions to address QA/QC problems, as necessary;
- Consulting with the Site Manager and/or Project Manager, as needed, on appropriate QA/QC measures and corrective actions;
- Arranging performance audits of measurement activities, as necessary; and
- Providing written reports on QA/QC activity to the Project Manager and Site Manager.

2.2 Problem Definition / Background (A5)

United Park is the current owner of a large parcel of property (the "Property"), comprising approximately 700 acres, located in Summit County, Utah. Figure 2.0 shows the general geographic location of the Property. The Site included a historic mine tailings impoundment, consisting of a large, geometrically closed basin formed by an earth embankment and a series of perimeter containment dikes and covers approximately 160 acres of the Property. The tailings impoundment resulted from decades of mining and milling silver-laden ore in the area around Park City known as the Park City Mining District. The Site is depicted in Figure 3.0.

The Site has remained unused since mining and milling operations ceased in 1982. Over the past fifteen years, the (EPA), the Utah Department of Environmental Quality (UDEQ) and United Park have been investigating the Site in order to characterize the Site and determine potential adverse impacts to human health and the environment associated with the Site. At the same time, United Park has been implementing a series of remedial measures at the Site intended to mitigate any potential adverse impacts on human health and the environment.

Based on available data from the Site and from similar tailings impoundments, United Park believes that the tailings impoundment as currently closed does not unacceptably impact upon, and does not otherwise pose unacceptable risks to, human health or to the

environment. United Park further believes that final Site closure can be achieved without the implementation of further remedial measures. On the other hand, United Park recognizes that EPA and UDEQ have expressed concerns about Site conditions that the agencies believe must be addressed through additional Site characterization and possibly through the implementation of additional remedial measures. Therefore, United Park proposes to use the data collected to date concerning the Site (after an evaluation of its suitability for use in the RI/FS process) and the data derived from the RI/FS, to facilitate an evaluation of the effectiveness and appropriateness of the existing in-place remedies and to further characterize the Site. The determination as to whether any further remedial measures are needed to support final Site closure will also be accomplished. If and to the extent further remedial measures are required at all, United Park believes that any appropriate final remedy for the Site should incorporate to the maximum extent practicable all existing elements of Site closure.

The RI/FS Work Plan outlines additional Site characterization work to be performed that will gather data to assist in the evaluation of the soundness and appropriateness of the existing remedies and, to the extent necessary, recommend additional remedial measures to support final Site closure. This and other data will also be presented for use by the EPA to perform a focused risk assessment. It will also be used in the RI/FS final reports both consistent with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 ("CERCLA") and the National Contingency Plan ("NCP") to support final site closure. A detailed description of the Site, including a description of the Site operational history, existing closure measures and elements, regional geology and hydrogeology and surface water is set forth in Sections 2.0 to 2.5 of the RI/FS Work Plan.

2.2.1 Historical Data Summary

Previous data have been collected by EPA, United Park and Park City Ventures (PCV). The historic data cover a time period beginning in the early 1970's up to the present. Appendix B contains a listing of known site investigations and reports. Because past investigation activities by PCV, Noranda and United Park were performed without EPA oversight, the results from such investigations will be evaluated as part of, and

incorporated as appropriate into, the RI/FS. A detailed description of the investigations previously conducted at the Site, which have included investigations of air quality, the extent of the tailings cover, tailings impoundment integrity and stability, and groundwater and surface water quality, are set forth in Sections 3.0 to 3.5 of the RI/FS Work Plan. Based on previous and current environmental studies and existing Site conditions, United Park has developed a preliminary model of the Site which is described in Section 4.0 of the RI/FS Work Plan. The preliminary site model has been developed to portray existing site conditions and more recent data and information that have been developed by United Park, and will be used to evaluate the need for additional Site characterization work to be performed as part of the RI/FS.

[Note: Although CERCLA guidance indicates that certain site descriptions that are already included in the RI/FS Work Plan need not be repeated, the descriptions set forth in the following Sections 2.2.1.1 to 2.2.2 are included to be more informative.]

2.2.1.1 Surface Water

Section 3.5 of the RI/FS Workplan presents a summary of historical surface water data for Silver Creek and the south diversion ditch. Surface water data have been collected on and near the Site since 1975 as part of permit requirements and investigations by EPA and United Park. The data generally show that metals concentrations measured in the south diversion ditch have declined particularly since the mid to late 1980's when the ditch was reconstructed and when the tailings were covered with clean soil (*See,* RI/FS Workplan, Table 3.1, Station N5). Data collected in 1999 indicate that zinc concentrations measured at the outfall of the ditch meet applicable water quality standards. Zinc concentrations exceed water quality criteria in the central portion of the diversion ditch and both upstream and downstream of the Site in Silver Creek. The downstream Silver Creek zinc concentrations are less than the upstream concentrations indicating that flow from the diversion ditch may be diluting the upstream zinc concentrations.

Table 3.3 in the RI/FS Workplan presents data collected in May and June of 1999. Additional data collected on the Site for the remainder of 1999 will be presented in the RI report. The 1999 data will be evaluated, following QA/QC criteria set forth in this SAP, to determine if the data, along with information collected in this RI/FS, can be used to guide decisions on what, if any, further remedial actions are required at the Site.

Metals measured in 1999 include RCRA metals, copper and zinc. The surface water analyte list was determined based on metals present in tailing samples collected by E&E in 1984. Complete cation/anion analytes were also measured at select stations. (*See*, RI/FS Workplan, RMC 2000). Mercury detection limits were not adequate to determine if the water in the diversion ditch meets the chronic aquatic wildlife criteria (12 part per trillion (ppt) – dissolved). Measured mercury concentrations at all site sample locations were non-detectable at less than 0.0005 mg/l. In May of 2000, mercury samples were collected on Silver Creek upstream and downstream of Richardson Flat and on the diversion ditch, as part of the Upper Silver Creek Watershed surface water sampling (*See,* Upper Silver Creek Watershed Analytical Results Report, August 2000, RMC). The detection limit for these mercury analyses was low enough to be below the chronic wildlife criteria. Analytical results indicated that both Silver Creek and the diversion ditch met the appropriate water quality criteria for mercury.

2.2.1.2 Ground Water

Groundwater quality data have been collected in monitoring wells located on and near the Site by EPA, United Park and PCV. The RI/FS Workplan and attachments discuss the historic and recent groundwater data. Initial review of the historic groundwater quality data suggests that this data will be of more qualitative than quantitative use. The procedures for QA/QC control detailed in this SAP will be used to determine the usability of the historic data. If the data do not meet QA/QC goals the data will be used to guide decisions based on a qualitative basis.

Historical groundwater data generally show that metals concentrations have steadily decreased in Site wells, with the exception of the upgradient well (RT-1) installed by EPA

in 1985 and MW-5 located at the toe of the main embankment (*See*, Figure 3.3, RI/FS Workplan). EPA sampled RT-1 in 1985 and again in 1992, total and dissolved metals concentrations had increased for aluminum, antimony, arsenic, and barium over the time period.

Comparison of data collected from RT-1 in 1984 and 1992 reveals that water quality appears to have deteriorated at this location over time. Some dissolved metal concentrations have increased from 1984 to 1992. The 1992 data contains some anomalies that suggest either the sample was contaminated or there were some analytical errors. Dissolved metal concentrations are greater than total metal concentrations for antimony, copper, and silver. This suggests that there are sample or analytical errors or interference. The well is completed in two aquifers and there is mixing of water between the two water bearing zones. During site visits in early 1999, it was apparent that the wellhead integrity had been jeopardized by vandals. It is not known if this was apparent in 1992. Thus, surface contamination may have impacted water quality.

A discussion of properly closing this well will take place in Section 3.2 of this SAP.

In 1973, PCV installed three monitoring wells (MW-1, MW-2 and MW-3) at the bottom of the main embankment as part of State of Utah requirements for the tailings impoundment operating permit. In 1976, PCV installed three additional wells (MW-4, MW-5, and MW-6). Figure 3.3 in the RI/FS Workplan shows the well locations. It appears that PCV buried monitoring well MW-2 in 1976 during installation of the three new wells. Thus, five groundwater monitoring wells are located near the toe of the embankment. The boring and well completion logs for these five wells can be found in Appendix D of the RI/FS Workplan and are summarized in Section 3.4 of the Workplan.

Table 3.2 in the RI/FS Workplan presents groundwater data collected by United Park from 1982 to 1987 and 1991 to 1998 from the embankment monitoring wells. Additional groundwater investigation is proposed as a part of the RI/FS Workplan. Details outlining sampling and analyses specifics are contained in this SAP.

In 1999, United Park hired Weston Engineering, Inc. ("Weston") to conduct a supplemental hydrogeological investigation of the Site. This study represented the most extensive groundwater investigation conducted to date to better understand groundwater systems on the Property. Weston evaluated historical Site and regional data to derive a conceptual hydrogeological site model (*See* RI/FS Workplan, Appendix A). In the course of its investigation, Weston installed eleven additional piezometers throughout the Property (*See* RI/FS Workplan, Plate 1, Appendix A). Boring logs from the piezometer installation verified the existence of two aquifers associated with the Property. Water level data collected from the piezometers indicates that the two aquifers are confined and are separated from one another by a significant layer of stiff, clay-rich material. Water level data collected after the installation of the piezometers and subsequent water level measurements indicate that the water levels in the two aquifers vary seasonally, with higher water levels occurring in the spring.

The data reported by Weston was not available to earlier Site inspection teams and other agencies that previously evaluated the Site. Studies by Dames & Moore identified the presence of clays in the naturally occurring material at the Site. It was not until Weston's investigation that extent or the significance of the natural clay material underlying the Property was known. The existence of two to five feet of clay-rich topsoil and the presence of the large area of silt and clay that overly the upper aquifer represent a significant barrier to the vertical migration of any water from saturated tailings. Weston has collected monthly groundwater data from February of 1999 to February 2000. These data will be evaluated in a supplemental hydrogeological study and submitted in the RI report. Any additional data that needs to be collected for this study will be done so in accordance with this SAP. Groundwater monitoring proposed as a part of this SAP will be used to verify the Site hydrogeological conceptual model as presented by Weston.

2.2.1.3 Soils

During investigations conducted by EPA and United Park, limited soils data were collected to primarily characterize the tailings soil cover and determine the extent of wind

blown tailings. In 1984, EPA collected one soil sample to document background metals and tailings concentrations. Generally, the 1984 data demonstrated that the tailings contain elevated concentrations of metals, and that the soil/tailings contact contains elevated metals, but at lower concentrations than the tailings. In 1992, EPA collected samples of the soil cover to determine the extent and thickness of the cover. Based on the 1992 sampling efforts, it was determined that most of the tailings were covered with clean soil or vegetation. Since 1992, United Park has covered any remaining exposed tailings.

2.2.1.3 Sediment

E&E collected four (4) sediment samples at the Site in 1992 in the "wetland" area between the main tailings embankment and Silver Creek. (*See* Final Report Richardson Flat Tailings, E&E, 1993) The data show that sediments in this area contain elevated concentrations of metals. Water from the south diversion ditch flows from east to west in the wetland area, while Silver Creek flows along the west side of the wetland area. The E&E data show that metals concentrations were elevated in the sediments, however, it appears that there is very little transfer of metals in the sediments to the water. Both historic and recent surface water data show that very little metal is being leached from the sediments. In 1985, E&E reported an increase in lead from 0.036 mg/l to 0.151 mg/l in upstream versus downstream Silver Creek surface water samples.

Additional sediment data will be collected in the diversion ditch as part of the RI/FS. The data collected from this sampling will be used to evaluate the long-term effectiveness of the wetland system to remove metals in the water, aid in the determination of the source of metal in water flowing in the diversion ditch and used in an ecological risk assessment to be conducted by the EPA. This data will also be applicable to evaluate long-term effectiveness of metal removal in the wetland area between the main embankment and Silver Creek.

2.2.2 Recent Environmental Conditions

The following conditions have been identified from field work and the chemical analysis of soil, surface and groundwater samples previously collected at the site by EPA's contractor E&E, United Park and PCV from 1985 to the present time:

- An imported clean fill covers the tailings surface, depth of the cover ranges from less than 6 inches to several feet thick.
- Tailings beneath the soil cover contain the following metals at elevated concentrations: antimony, arsenic, cadmium, copper, lead, mercury, selenium and zinc (EPA, 1992).
- Surface water on and near the Site contains the following metals at low concentrations: arsenic, cadmium, copper, iron, lead, and zinc (RI/FS Workplan, 2000). Of the metals detected, only zinc and possibly mercury exceed water quality standards. However, Silver Creek is currently moving through a TMDL process for elevated levels of zinc and cadmium. Zinc levels upstream and downstream of the Site on Silver Creek exceed protection of aquatic wildlife criteria. Laboratory detection limits for mercury were low enough to verify that all samples collected in 1999 were non-detected for mercury at 0.0005 mg/l. The acute aquatic wildlife criteria for mercury is 0.0024 mg/l and the chronic aquatic wildlife criteria for mercury is 0.000012 mg/l or 12 parts per trillion.
- Shallow groundwater at the downstream face of the main tailings embankment contains the following metals at low concentrations: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury nickel, selenium, silver, thallium, vanadium, and zinc. Of the metals detected, only lead exceeds the Utah Ground Water Quality Standard. (RI/FS Workplan, 2000).
- Data collected by E&E in 1992 show that sediments in the wetland below the main embankment contain the following metals at elevated levels: antimony, arsenic cadmium, lead, mercury, selenium and zinc. Surface water data from the wetland area, collected at the same time as the sediment data, show that only lead was elevated when compared to upstream concentrations. It is likely that the wetland sediments,

that are rich in organic carbon, are binding the metals and not allowing significant mobilization of metals to occur.

There have been several investigations conducted on the Site by EPA, United Park and PCV over the past fifteen years, Appendix B contains a listing of known site investigation reports.

2.3 Project/Task Description (A6)

As summarized in the RI/FS Work Plan, extensive investigation work has already been completed at the Site. Moreover, over the years, United Park and others have taken actions to support final closure of the Site, including the installation of a soil cover over the tailings, drainage ditches, and a security fence. In order to evaluate the need for further remedial measures needed to support final Site closure and to assure that the existing remedies in place are adequate and have longevity, United Park will conduct the additional remedial investigation work described in Sections 5.0 to 5.7 of the RI/FS Work Plan.

The purpose of this SAP is to guide additional sampling of environmental media in support of the RI/FS. The SAP will identify sample types, number of samples to be collected, and establish sample collection and analytical procedures.

The following objectives of the remedial investigation are:

1. Collect soil, sediment, and water samples to further characterize Site conditions.
2. Provide data to fill data gaps due to seasonal variations in media such as groundwater and surface water.
3. Evaluate existing data to determine the need for further data collection.
4. Collect data of sufficient quality and quantity for EPA to conduct a streamlined risk evaluation.
5. Through this SAP, establish procedures for data collection and analysis.

6. Through this SAP, define Quality Assurance/Quality Control (QAQC) measures.
7. Through this SAP, provide a Site Health & Safety Plan for all workers and visitors.

2.4 Data Quality Objectives for Measurement Data (A7)

Data Quality Objectives (DQOs) are quantitative and qualitative statements specifying the quality of the data required to support decisions during site investigations and removal actions. DQOs and associated data quality levels are based on the end uses of the data and are determined by the methods of analysis and the level of QC and documentation that are used to produce the data. Tables 1 and 4 summarize the DQOs, data uses, analytical methods, and QC level required for the sampling. All data collected during the RI/FS, except for decontamination water samples collected for pH testing in the field, will be considered "definitive" consistent with EPA Superfund Data Categories (EPA, 1993) and (Table 1). pH testing does not fall within the Superfund Data Categories (EPA, 1993), and for the purpose of this plan will be considered Screening. Screening and Definitive data are defined as follows:

- Screening data will be defined as data collected by Standard Operating Procedures (SOP's), such as water-level measurements and pH measurements, using field instruments calibrated according to manufacturer's specifications and SOP's. The data deliverables produced and QC documentation are not as rigorous as requirements for Definitive data. The data may be used for site monitoring and characterization.
- Definitive data will be defined as data produced using EPA-approved methods. The data deliverables may or may not be equivalent to Contract Laboratory Procedures (CLP) Routine Analytical Services (RAS). However, the data deliverables produced and the QC documentation may not be as rigorous as the CLP requirements for documentation. The data may be used for risk assessment, site characterization, and site monitoring.

DQOs are expressed in terms of precision, accuracy, representativeness, comparability, and completeness (PARCC). Table 3 summarizes the quality assurance goals in terms of the five PARCC criteria.

3.0 MEASUREMENT / DATA ACQUISITION (B)

This SAP is intended to be a guide for United Park's Project Manager, field personnel and EPA's oversight contractor in implementing the remedial investigation at the Site. This section addresses all aspects of the collection and measurement systems design and implementation ensuring that appropriate methods for sampling, analysis, data handling, and QC are employed and documented.

A 2' topographic map is available. This digital map was prepared in the summer of 1998. All surveying to be completed for the RI/FS will b tied to the coordinate system for this map. Points will be established on the groud for referencing any hand-held GPS equipment used in the study.

3.1 Sampling Process Design (B1)

All sampling measurements described below are required to achieve the project objectives. The focus of sample collection activities proposed in this SAP is evaluation of the following environmental media:

- Surface Water sampling of Silver Creek, the Diversion Ditch and the ponded water within the impoundment.
- Groundwater sampling for water quality and elevation in the existing wells and wells associated with the evaluation of the shallow aquifer in Silver Creek.
- Soils sampling off site to evaluate the migration of contaminants.
- Sediment sampling in the Diversion Ditch to support the Risk Analysis, the study of the long-term viability of the wetlands in the ditch and to determine the contribution, if any, to the metal loading in surface waters flowing in the ditch.

- Samples of the soil cover over the tailings to determine depth of cover and any surface contamination.
- Tailings sampling to support the determination of the long-term chemical stability of the tailings.

3.1.1 Surface Water

Surface water samples will be collected at a minimum of five (5) locations on or near the Site as depicted on Figure 4. The sample locations were selected based on data collected in 1999 and 2000. Data from these sample locations will be used to characterize seasonal water quality and quantity in the main Ditch, as well as the unnamed drainages flowing into the south diversion ditch and Silver Creek. Furthermore, the data will be used to determine the effect(s) of the Site on Silver Creek water chemistry and provide information in support of a study to determine the source of elevated zinc concentrations found in the middle reach of the diversion ditch. Samples will be collected monthly at each location through at least one complete seasonal time period. United Park intends to use data collected at these stations in 1999 to complete the annual cycle of data collection. The 1999 and 2000 data will be evaluated for QA/QC requirements found in this document. If the 1999 and 2000 data do not pass QA/QC requirements, then additional data will be collected to fill in the data gaps.

The samples will be collected according to the RMC Standard Operating Procedures (SOP) for Surface Water Sampling SOP-1 presented in Appendix C. Field and laboratory analytical parameters are shown on Table 2 of this SAP. Sample collection will be conducted according to procedures in Section 3.2. Analytical and laboratory procedures that will be followed are detailed in Section 3.4 of this SAP. Actual sample locations and surface water elevation data will be logged with a Global Positioning Survey (GPS) unit or located with conventional survey methods.

3.1.2 Ground Water

United Park will install two monitoring wells in the Silver Creek shallow alluvial aquifer. The wells will be installed upgradient and downgradient of the Site as shown on Figure 4. Existing wells may be used to the extent possible. Groundwater and surface water levels will be measured at each location to determine flow characteristics between the surface and groundwater system. Samples will be collected monthly starting after installation and continue for twelve (12) months. Water level and quality data from the wells will be used to verify the Site conceptual hydrogeologic model and determine what, if any, impacts to the shallow alluvial aquifer adjacent to Silver Creek are occurring from the Site. The hydrogeological model presented by Weston (Appendix A, RI/FS Workplan, 2000) shows that the shallow aquifers present near the Site are separated from the tailings aquifer by a 10-15 foot clay soil layer. Groundwater quality data to date only suggest that the monitoring wells on the downstream face of the main embankment contain elevated levels of metals and only in wells completed within the top six feet of the ground surface. Beyond seepage across the tailings embankment, there is no apparent hydraulic connection between groundwater stored in the tailings and underlying and adjacent shallow alluvial aquifer(s). (*See* Weston, 1999)

The monitoring wells will be installed according to the RMC SOP-3c (Ground Water Monitoring Well Installation) presented in Appendix C. Field and laboratory analytical parameters are shown on Table 2. The proposed monitoring well locations are shown on Figure 4. Sample collection will be conducted according to procedures in Section 3.2, analytical and laboratory procedures that will be followed are detailed in Section 3.4 of this SAP. Section 3.2, Sampling Methods, describes the procedures that will direct sample collection. The well locations will be logged with a Global Positioning Survey (GPS) unit or located with conventional survey methods.

3.1.3 Soils Cover Sampling

At approximately (forty-two) (42) locations, soil samples will be collected on the tailings impoundment to determine: 1) the extent and thickness of the soil cover and 2) chemical characteristics of the surface soils. EPA will use this data, in the risk assessment process to evaluate the potential for impacts to human health and the environment from the Site soils. Sample locations are shown on Figure 5. Samples will be collected at the surface (0-2") at each location and initially analyzed for lead and arsenic to characterize the cover materials for potential risk to humans from exposure to the cover soils. If the surface samples contain levels of lead greater than 500 ppm and/or arsenic greater than 250 ppm, then additional analytes will be measured. Additional analytes will include RCRA metals zinc and copper. The thickness of the soil cover will be determined by excavating either by hand, core sampler or backhoe down to the soil/tailings interface. The interface will be visually verified at each location; the tailings are a characteristic grey color, sandy texture, while the soil cover is red-brown color and has a clayey texture. Approximately ten (10) samples will be collected just above the cover/tailings interface and submitted for laboratory analyses to verify the visual method. Table 2 lists the target metals for the depth of cover samples, target metals were selected based on results of the E&E air monitoring activities conducted in 1984. The surface sample (0-2") data will be used by EPA determine if the cover material presents a threat to human health or the environment.

At approximately twenty-four (24) locations, soil samples will be collected along three transects, oriented perpendicular to the prevailing wind direction, to assess the extent and potential human health and/or environmental impacts from wind blown tailings. Sample locations are shown on Figure 6. Samples will be collected at 0-2" and 1-6" intervals along the transects indicated on Figure 6. Data from this sampling effort will be used in the risk assessment process to evaluate if there is a threat to human health or the environment from exposure to off-site soils.

All soil sample locations are shown on Figures 5 and 6. Sample collection will be conducted according to procedures in Section 3.2 Analytical and laboratory procedures are detailed in Section 3.4 of this SAP. Actual sample locations will be logged with a Global Positioning Survey (GPS) unit or located with conventional survey methods.

3.1.4 Sediment

At approximately six (6) locations, sediment samples will be collected in the south diversion ditch. These samples will aid in the determination of the source of elevated zinc concentrations in water samples collected in 1999 and 2000. Sufficient sample will be taken for additional testing if desired. Long term fate and transport modeling of metals in the sediments (*See,* RI/FS Workplan, Table 3.4) will be performed to evaluate risk to the environment from metals bound in the organic substrates within the diversion ditch sediments. The samples will be collected at locations shown on Figure 5. At each location, samples will be collected at the surface and down to a depth of six (6) inches. The sediment samples will be analyzed for metals in soils listed in Table 2. These samples will be maintained should it be determined that additional analysis is required.

All sediment sample locations are shown on Figure 5. Sample collection will be conducted according to procedures in Section 3.2. Analytical and laboratory procedures are detailed in Section 3.4 of this SAP. Actual sample locations will be logged with a Global Positioning Survey (GPS) unit or located with conventional survey methods.

3.1.5 Tailings

At three (3) locations, samples of tailings will be collected within the impoundment. The purpose of this sample collection effort will be to collect data to evaluate the ling-term fate of the metal in tailings and the chemical stability of the tailings. Presently, environmental data suggest that very little if any leaching of metals is occurring. The samples will be collected at locations shown on Figure 5. At each location, five (5) discrete samples will be collected at one (1) foot vertical increments, starting from the bottom of the cover over the tailings down to a depth of five (5) feet below the ground surface. Sample and analytical procedures will be consistent with sections 3.2 and 3.4 of this SAP. The discrete samples will be analyzed for metals in soils presented in Table 2. In addition, a composite sample comprising a split of each increment will be prepared and analyzed for acid/base potential in order to allow prediction of long term geochemical characteristics of

the tailings materials. The samples will either be collected by excavating a test pit with a backhoe or with direct push methods. The Project Manager, following discussions with the EPA Project Coordinator will make this determination in the field.

3.1.5.1 Delineation of Tailings South of the Diversion Ditch

The tailings outside of the impoundment have been covered with at least one to up to fifteen feet of clean soil (*See* Section 4.2, RI/FS Workplan). The actual limit and extent of the tailings south of the diversion ditch will be identified using a combination of aerial photography review and investigative field methods. The approximate limits of these tailings are marked with a dashed green line as the "tailings outside of the impoundment" on Figure 5.0. The results of this investigation will aid in providing a definitive model of the extent of the tailings located south of the diversion ditch and to define study boundaries. Subsurface samples will be collected to determine: 1) the extent of tailings south of the south diversion ditch, 2) the thickness of soil cover on these tailings, and 3) if these tailings are contributing to elevated zinc levels in the diversion ditch.

As described in Section 5.2 of the RI/FS Workplan (RMC, 2000), the purpose of this sampling effort is to evaluate the potential for tailings in this location to impact groundwater and surface water in the south diversion ditch. Data collected will be used in conjunction with the sediment samples collected from the Diversion Ditch. Subsurface samples will be collected using a combination of shallow hand tool excavation, backhoe test pits, boreholes or direct push methods. These four methods will involve the visual inspection of subsurface soils. To confirm the results of visual inspection, analytical samples will be collected at 10% of the locations visually inspected. The analytical soil samples will be collected above and below any color or texture changes. The soil samples will be analyzed for metals in soils presented in Table 2.

If groundwater is present in the tailings, monitoring wells will be installed. The wells will be sampled following procedures specified in Section 3.2.2. Based on the outcome of the

groundwater evaluation, United Park may collect additional subsurface data to determine the volume, extent and environmental impacts from tailings in this area.

A review of historical aerial photographs will be conducted to assess the outermost limits of the tailings south of the diversion ditch. The approximate location of tailings will be determined from reviewing a series of historical aerial photographs. Where possible, the location of the tailings will be determined by examining the photographs for discontinuities that may be indicative of the boundaries of the tailings and native ground. These discontinuities may include changes in plant cover, drainage patterns and general geomorphology. The locations of the tailings/native ground boundary will be compared to the locations of known points such as fencing and roads. The boundary will then be staked on the ground using the known points as reference locations. The staked boundary locations will act as a starting point for the field delineation of the tailings/native ground boundary.

The extent of the tailings will be staked during the field investigation. At the completion of field activities, the boundary will be surveyed using conventional survey techniques. The survey data will be used to update the current boundary on Figure 5.

Sample location, collection and laboratory procedures that will followed are detailed in Section 3.2 of this SAP.

Analytical soil sample collection will be conducted according to procedures in Section 3.2, analytical and laboratory procedures that will be followed are detailed in Section 3.4 of this SAP. Actual sample locations will be logged with a Global Positioning Survey (GPS) unit or located with conventional survey methods.

3.2 Sampling Methods Requirements (B2)

Sampling method requirements for each sample type are described below. Table 4 summarizes the sample containers, preservation requirements, and analytical holding times for each analytical method.

3.2.1 Surface Water Samples

Surface water samples will be collected following RMC's SOP 1, included in this SAP as Appendix C. These procedures will be followed for any water samples collected in this RI/FS. Water samples will be collected at five (5) locations on or near the Site, as shown on Figure 4. Analytical parameters vary depending on the data objective at each location. For the most part, complete cation/anion and metals (dissolved and total) samples will be collected. Table 1 presents the data quality objectives, target analytes for each sample location, number of sample containers, preservative and collection methods for each location. At each location, field data, including pH, temperature and specific conductivity will be collected after the laboratory sample has been collected, preserved and stored. Field data requirements are presented in Table 2.

3.2.2 Ground Water Samples

Groundwater quality samples will be collected at two (2) new monitoring wells installed in the Silver Creek alluvial aquifer. Additional data collected will include field parameters (as with surface water samples) as well as water elevation in the well. Elevations will be referenced to the ground surface adjacent to the well. Figure 4 shows the approximate locations of the monitoring wells. In addition, sampling of existing wells will occur in accordance with this RMC SOP 3c and this SAP. Two wells will be installed to sample the shallow groundwater in the Silver Creek floodplain. These wells will be installed according to SOP 3a. Prior to sampling, the wells will be developed according to SOP 3b. The wells will be sampled according to RMC SOP 3c. Field data and analytical requirements are presented in Table 2. After installation, a licensed land surveyor registered in the State of Utah will survey the locations of the new wells. Surveying will include horizontal coordinates (Northing and Easting) for the well location, and vertical elevation datum for the top of casing. Vertical accuracy will be within 0.01 feet and horizontal accuracy will be within one (1) foot.

One existing groundwater well, No. RF-1, will be sampled and then closed in accordance with standard procedures for abandoning and closing wells as set forth by the State Engineers Office.

3.2.3 Soils

3.2.3.1 Surface Soil Samples

Surface soils (0-2") will be collected following RMC's SOP 2a, included in this SAP in Appendix C. The surface of the soil will be scraped free of vegetation from the sample location with a shovel, stainless steel spoon, or disposable sampling instrument. The underlying soil sample will then be collected with a stainless steel spoon or gloved hand and placed into a plastic bag, labeled and sealed with a chain-of-custody seal. Coarse-grained soils such as gravel and rock fragments will be discarded. The sample location will be surveyed with either a GPS unit or a licensed land surveyor.

3.2.3.2 Soil Samples at Depth

Samples collected at depth will follow SOP 2b, included in this SAP in Appendix C. Surface vegetation will be scraped away from the sample location with a shovel, stainless steel spoon, or disposable sampling instrument. The target depth increment sample will be collected by one of the following methods: hand-powered auger, soil probe, shovel, or stainless steel trowel. For tailings samples, equipment such as a backhoe or geoprobe will be used as appropriate. This equipment will be operated by a professional operator and arranged for by the Project Manager. All appropriate safety precautions will be taken when working around this equipment. At each increment, the sample will be placed into a plastic bag, labeled and sealed with a chain-of-custody seal. The sampling equipment will be decontaminated between each depth increment. If the sampling is to evaluate the cover material over the existing tailings, then the character of the sediment encountered will be noted. That is, color, texture and composition will be noted. The samples will be analyzed in accordance with section 3.4 of this SAP.

This section also applies to sampling of tailings below ground surface. When tailings are encountered for sampling, the resulting exposed tailings will be covered with soil not tailings. The objective is to not have tailings exposed after sampling.

3.2.4 Sediment Samples

Sediment samples will be collected in accordance with RMC's SOP-4, included in Appendix C. At each of the locations shown on Figure 5, a discrete sample will be collected at the surface and down to a depth of six (6) inches below the surface. Samples will be collected using either a hand auger, shovel, or geoprobe methods. All samples will be sieved by the laboratory to recover the silt/clay fraction (<63 microns) for analysis.

3.3 Sample Labeling, Handling, Custody, and Documentation (B3)

3.3.1 Labeling

Each sample container will be immediately labeled with the following information:

- Project name
- Project number
- Sample identification and location
- Date and time collected
- Analyses requested
- Sampler's initials

Samples will also be labeled as to whether or not they contain any preservatives. Also, their origin will be noted. For example, the sample will be labeled as to whether or not it is tailings, sediment, soils surface or ground water.

Duplicate samples will be given a sample identification number in the same fashion as normal samples such that the laboratory cannot distinguish them as duplicates.

3.3.2 Sample Handling

All samples will be collected in appropriate containers supplied by the laboratory as specified in Table 4, and promptly placed in an iced cooler to maintain a temperature of 4 °C. Typically, samples selected for chemical analysis are delivered at the end of each day to the analytical laboratory. If they are not submitted to the laboratory on the same day collected, they will be refrigerated in a locked sample storage room at RMC's office until delivery to the laboratory.

3.3.3 Chain-of-Custody

Chain-of-custody procedures will be observed and documented. Chain-of-custody documentation will begin in the field for each sample submitted to the laboratory and will also be maintained by laboratory personnel. A chain-of-custody form (Appendix D) will be completed and will accompany each sample cooler to the analytical laboratory. Sample custody means that all samples will remain in the possession or observation of the sampler at all times, or in a locked facility until delivery to the analytical laboratory.

.3.4 Documentation

The field personnel will maintain a weather resistant, hardbound sample logbook. The logbook will include the sample identification, sample date, type of sample, and analyses requested. Information specific to the type of sample will also be included, as follows:

- Confirmation Soil Samples - Include the sample number and location to confirm the surveyed location.
- Decontamination Fluid - Include the quantity of water in the sample batch and the type of sampling equipment decontaminated.

3.4 Analytical Methods Requirements (B4)

Analytical methods, with corresponding laboratory reporting limits (LRLs) are specified on Table 2. Samples will be submitted to American Environmental Consultants Laboratory (AEC) in Salt Lake City, Utah. AEC is certified with the State of Utah. Appendix E contains AEC's QA/QC manual, and certification letters from the Utah Department of Health and Division Bureau of Laboratory Improvement. If another lab performs analyses, it must meet the following criteria and submit all QA documentation to the EPA for approval as described above:

- Demonstrated ability to achieve the required detection limits,
- Certified by the State of Utah, and
- Follows an internal QA/QC program.

3.5 Quality Control Requirements (B5)

Quality control will include collecting field duplicates at a rate of 10 percent of the sample load for each sample type, and ensuring that the laboratory runs matrix spike/matrix spike duplicates at a rate of five percent of the sample load for each sample type. The field duplicates will be submitted "blind" to the sample laboratory, i.e., they will be given a separate sample identification number from the environmental sample, unidentifiable to the laboratory, as described above. Field duplicates will be run for the same analytical suite as the environmental samples.

Matrix spikes and matrix spike duplicates will be selected at random by the laboratory. Separate samples do not need to be collected in the field. The laboratory will perform and report all analyses under QA/QC procedures that include the results of method blanks, laboratory control samples, matrix spikes, matrix spike duplicates, and the relative percent difference between the matrix spike sample and duplicate.

Due to the nature of the contaminants at this site, ambient, equipment and trip blanks will not be collected.

3.6 Instrument Calibration & Frequency (B7)

3.6.1 Field Instruments

RMC will follow the manufacturer's specifications to calibrate any field equipment prior to each use. These manufacturers specifications are included in RMC's SOP's. A record of the calibration will be kept in the field logbook.

3.6.2 Laboratory Equipment

Procedures and schedules for the calibration of laboratory equipment are described in the appropriate SW-846 and EPA methods, and in the laboratory's Quality Assurance Plan. These procedures and schedules will be followed for all laboratory work.

4.0 ASSESSMENT / OVERSIGHT (C)

4.1 Assessments and Response Actions (C1)

UPCM will assess the results of sampling of soils, water, sediment, and tailings as the results are reported from the laboratory, and will forward the results to the EPA Project Manager Jim Christiansen.

Response actions to non-conforming samples will be decided by United Park and RMC will be conveyed to EPA.

5.0 DATA VALIDATION AND USABILITY (D)

5.1 Data Review, Validation & Verification Requirements (D1)

The data validation process evaluates whether the specific requirements for an intended use have been fulfilled and ensures that the results conform to the users needs. The data validation process develops the QC acceptance criteria or performance criteria.

Data verification confirms that the requirements of the specified sampling and analytical methods were followed. This process involves reviewing the results of sampling and analysis to determine conformance with the QC requirements described for the project. The data verification process ensures the accuracy of data by using validated methods and protocols, and is often based on comparison with reference standards.

Requirements and methods for data validation and verification are listed in Table 3 and 4.

5.2 Validation & Verification Methods (D2)

Data will be reviewed to ensure that the requirements stated in Tables 3 and 4 were met. Data validation and verification will be conducted using the methods described in Table 3. A minimum of 90 percent of the data will be validated. Data will be reviewed as it is received, continuously throughout the project. Any observed deviations will be immediately addressed by the Project Manager. Laboratory QC issues will be addressed immediately by communication between the Project Manager and the Laboratory Project Chemist. The Project Manager will immediately notify EPA of any data validation or verification issues that may affect the success of the project.

Any deviations from the analytical control limits specified in Table 3 and 4 will be evaluated in terms of their effect on the data usability. The degree of sample deviation beyond acceptance limits will be evaluated for its potential effect on data usability,

contribution to the quality of the reduced and analyzed data, and on decision-making for the project. The completeness goal for the project is 90 percent valid data.

The results of the data validation and verification will be summarized in a Data Review Report, to be prepared after the completion of sampling and analysis activities at the site.

5.3 Reconciliation with Data Quality Objectives (D3)

The data validation and verification results will be compared to the DQOs stated in Table 1 and with the PARCC parameters described in Table 3. This evaluation will summarize the QA/QC performance by PARCC criteria including completeness calculations expressing the percent complete of valid data compared to the total number of samples collected. The result of the data validation and verification will be summarized in Data Review Report described above.

FIGURES

Chain of Command

Geographic Location of Site

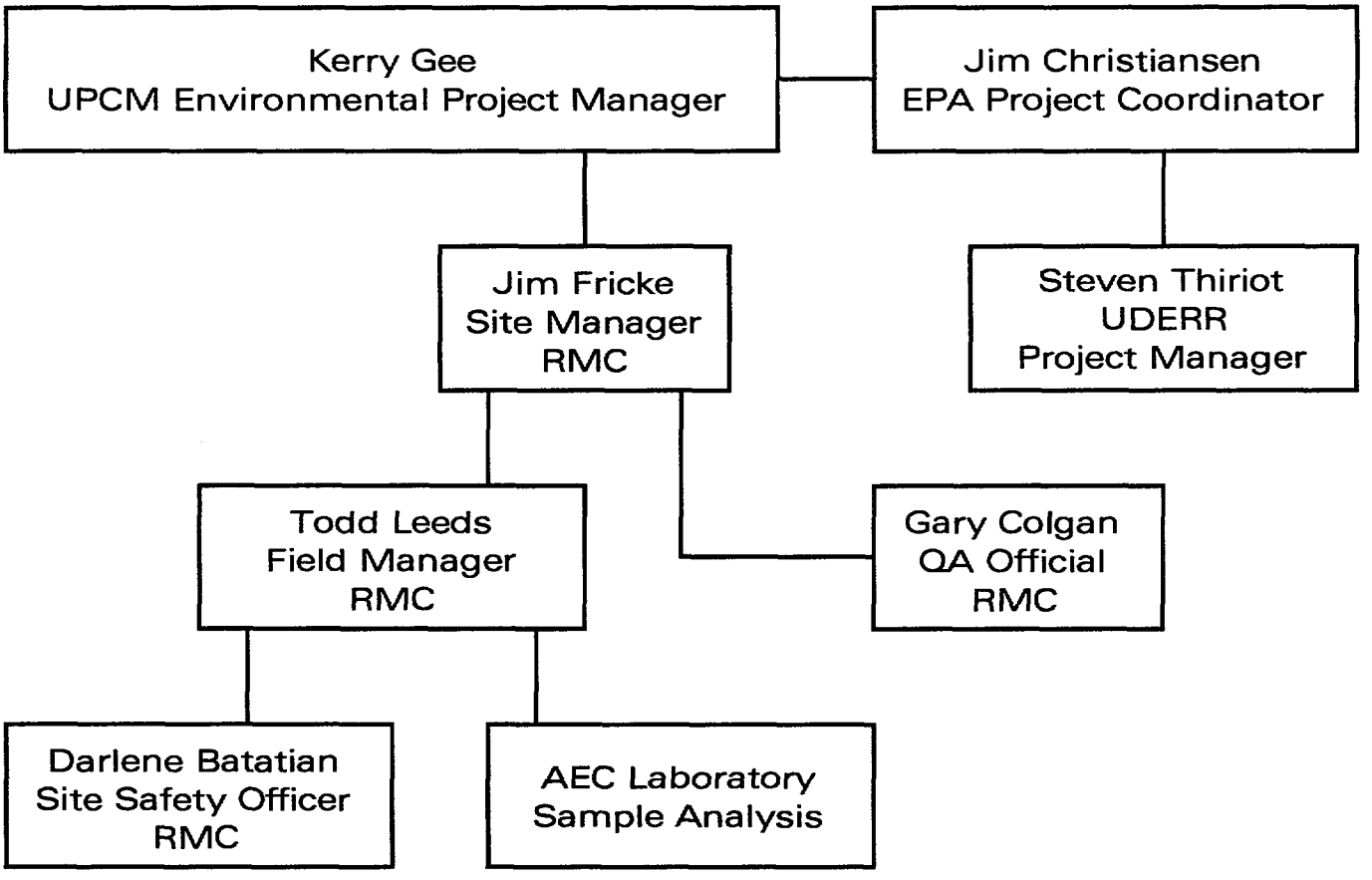
Site Map

Surface Water and Ground Water Locations

Soil/Sediment/Tailings Sample Locations

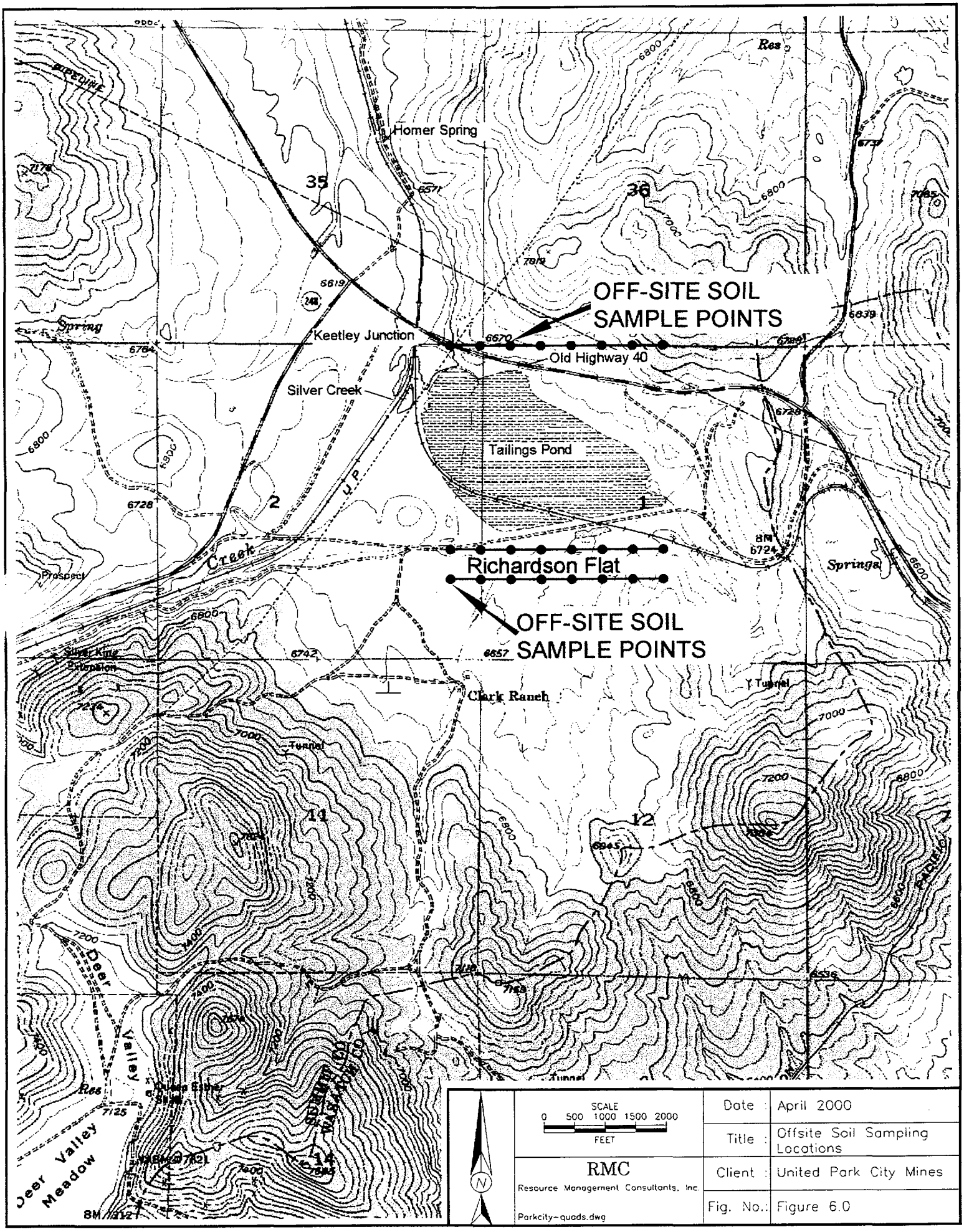
Offsite Soil Sample Locations

FIGURE 1 - Richardson Flat RI/FS Organizational Chart



Color Chart(s)

The following charts contain color that does not appear in the scanned images.
To view the actual images please contact the Superfund Record Center at (303) 312-6473.


Homer Spring
OFF-SITE SOIL SAMPLE POINTS
Keetley Junction
Old Highway 40
Silver Creek
Tailings Pond
Richardson Flat
OFF-SITE SOIL SAMPLE POINTS
Clark Ranch
Deer Valley
Deer Valley Meadow
SCALE
0 500 1000 1500 2000
FEET
N
RMC
Resource Management Consultants, Inc.
Parkcity-quads.dwg
Date : April 2000
Title : Offsite Soil Sampling Locations
Client : United Park City Mines
Fig. No.: Figure 6.0

TABLES

Data Quality Objectives, Uses, Types and QC Levels

Target Analytes and Collection Requirements

PARCC

Data Validation and Verification Requirements

Sample Locations and Descriptions

TABLE 1

Data Quality Objectives, Data Uses, Data Type and QC Levels
Richardson Flat
Sampling and Analysis Plan

Data Quality Objectives	Data Uses	Data Type	QC Level
Sample surface water on and near Richardson Flat	Identify source areas of contamination affecting water quality in diversion ditch and augment previous data.	Water Quality Analysis pH Measurement	Definitive Screening
Sample Site soils including; tailing cover soils both on and off the impoundment and offsite wind blown tailings	Determine extent of tailings cover and quantify cover chemistry. Determine extent of wind blown tailings, provide data to EPA to evaluate risk to human health and environment from wind blown tailings.	Soil Analysis	Definitive
Sample sediment in south diversion ditch	Determine nature and extent of metals in diversion ditch, evaluate wetland removal processes for long term stability	Soil Analysis	Definitive
Sample groundwater in Silver Creek alluvial aquifer.	Evaluate upstream and downstream water quality in Silver Creek alluvial aquifer for impact from tailing impoundment.	Water Quality Analysis pH Measurement	Definitive Screening
Sample tailings on and near impoundment	Evaluate long term stability and fate and tranport of tailings geochemistry	Soil Analysis	Definitive

* - Level III data are considered to be "definitive" (EPA 1993)

TABLE 2

Sample Collection Guide - Target Analytes and Collection Requirements
Richardson Flat
Sample and Analysis Plan

Soils

Parameters	Method	LRL[2]	Container	Volume[4]	Temperature	Preservative	Hold Days
Ag,As,Cr, Fe	SW-846 6010	5	Glass	4 oz.	4°C	N/A	180
Al,Cu,Pb,Sb,Se,Zn	SW-846 6020	5	Glass	4 oz.	4°C	N/A	180
Cd	SW-846/6010B	0.5	Glass	4 oz.	4°C	N/A	
Mercury	SW-846/7471	0.1	Glass	4 oz.	4°C	N/A	28

Water

Parameters[1]	Method	LRL[3]	Container	Volume[4]	Temperature	Preservative	Hold Days
pH (Field)	Digital Meter	NA	Polyurethane	Bottle 5	4°C	None	1
Ag,As,Mn (Total & Dissolved)	SW-846 6010	0.005	Polyurethane	Bottle 1,2	4°C	2 ml HNO_3	180
Cd,Cu,Pb,Sb,Se (Total & Dissolved)	SW-846 6020	0.005	Polyurethane	Bottle 1,2	4°C	2 ml HNO_3	180
Cr (Total & Dissolved)	SW-846 6010	0.01	Polyurethane	Bottle 1,2	4°C	2 ml HNO_3	180
Al (Total & Dissolved)	SW-846 6020	0.05	Polyurethane	Bottle 1,2	4°C	2 ml HNO_3	180
Zn (Total & Dissolved)	SW-846 6020	0.01	Polyurethane	Bottle 1,2	4°C	2 ml HNO_3	180
Fe (Total & Dissolved)	SW-846 6010	0.1	Polyurethane	Bottle 1,2	4°C	2 ml HNO_3	180
Hg (Total & Dissolved)	EPA 245.1	0.0002	Polyurethane	Bottle 1,2	4°C	2 ml HNO_3	13
Ca, K, Mg, Na	SW-846 6010	2	Polyurethane	Bottle 3	4°C	None	180
Cl	EPA 325.2	1	Polyurethane	Bottle 3	4°C	None	28
NO_3, NO_2	EPA 353.2	0.1	Polyurethane	Bottle 4	4°C	H_2SO_4	28
CO_3, HCO_3	EPA 310.1	1	Polyurethane	Bottle 3	4°C	None	28
NH_3	EPA 350.1	0.1	Polyurethane	Bottle 4	4°C	H_2SO_4	28
PO_4	EPA 365.1	0.1	Polyurethane	Bottle 4	4°C	H_2SO_4	28
SO_4	SW-846 9036	2	Polyurethane	Bottle 3	4°C	None	14
Alkalinity	EPA 310.1	1	Polyurethane	Bottle 3	4°C	None	14
Conductivity	Digital Meter	10	Polyurethane	Bottle 5	4°C	None	28
Hardness	2340B	N/A	Polyurethane	Bottle 3	4°C	None	60
Cation/Anion Bal.	Calculation	N/A	Polyurethane	N/A	4°C	None	NA
TSS	EPA 160.2	1	Polyurethane	Bottle 3	4°C	None	7
TDS	EPA 160.1	10	Polyurethane	Bottle 3	4°C	None	7

N/A - Not Applicable
LRL - Laboratory Reporting Limit

[1] Field Data Collected for each sample station/event includes:
pH, Conductivity, Temperature, Flow

[2] All units are Parts Per Million (ppm) unless otherwise noted.

[3] Measurement Unit based upon dry weight, LRL based on matrix.

[4] Laboratory analysis for the above parameters will require collection of the following sample volumes/preservation at each sample station:

Bottle 1 - 500 ml bottle filtered to 0.45µm and preserved with 2 ml HNO_3
Bottle 2 - 500 ml bottle unfiltered and preserved with 2 ml HNO_3
Bottle 3 - 1000 ml bottle unfiltered and unpreserved
Bottle 4 - 500 ml bottle unfiltered and preserved with 2 ml H_2SO_4
Bottle 5 - 500 ml bottle unfiltered and unpreserved for field parameters.

TABLE 3

Precison, Accuracy, Representativeness, Comparability and Completeness (PARCC)
Richardson Flat
Sample and Analysis Plan

Parameter	QC Program	Evaluation Criteria	Summary of QA/QC goals
Precision	Field Duplicate	Relative Percent Difference (RPD)	RPDs: soil, sediment and water samples +/- 35 percent if > 5 times LRL, or, +/- LRL if < 5 times LRL
	Matrix Spike	Reproducibility	
	Matrix Spike Duplicate	Reproducibility	
Accuracy	Matrix Spike	Percent Recovery	QA/QC analysis results fall within Laboratory Control Limits [1]
	Matrix Spike Duplicate	Percent Recovery	
	Laboratory Control Samples	Percent Recovery	
	Lab-Specified Historical Limits		
Representativeness	Hold Times	Representative of Environmental Conditions;	Holding Times Met 100 Percent
	Method Blanks	Qualitative Degree of Confidence	No Method Blank Contamination
	Field Duplicates		90 Percent of Field Duplicates Meet RPD Goals
Comparability	Standard Units of Measure	Qualitative Degree of Confidence	Laboratory Methods Followed
	Standard Analytical Methods		SOPs Followed
	Field Duplicate Pairs		
Competeness	Complete Sampling	100 Percent Valid Samples	90 Percent Valid Data

[1] Laboratory Control limits are specific to individual analytical/digestion methods and any deviation outside control limits are reported

Precision is a measure of how repeatable data is and is often measured by sample duplicates.
Accuracy is a measure of how close the data is to the actual, or real value, measured by certified reference materials and matrix spikes.
Representativeness is a measure of how representative a sample is to the sample population and is achieved by accurate sampling procedures and appropriate sample homo
Comparability looks at ongoing projects and how variable one set of data is to another. Comparability helps to measure the scientific coherence of the system to past work .
Completeness is a measure of how many data points collected are usable; 90% usable data is considered to be an acceptable value for completeness.

TABLE 4
Data Validation and Verificaiton Requirements
Richardson Flat
Sample and Analysis Plan

Data Validation and Verification Requirements		Data Validation and Verification Methods
Samples were collected according to established locations and frequencies.	→	Comparison with Sampling Plan
Sample collection and handling followed established procedures.	→	Review of field notes, field procedures and COCs
Appropriate analytical methods were used; and internal laboratory calibration checks were performed according to the method-specified protocol.	→	Review of analytical methods and case narratives provided with laboratory reports. Documentation of any communications with laboratory concerning problems or corrective actions.
Required holding times and laboratory reporting limits were met.	→	Comparison with established holding times and LRLs.
Field Duplicates for QA/AC		field duplicaes met acceptance criteria tabulation of RPDs and comparison with PARCC parameters
Recovery acceptance limits for field and laboratory QC samples (field blanks, field dups, equipment blanks, method blanks) were met.	→	Tabulation of RPDs and spike recoveries, and direct comparison with LRL's. Comparison with PARCC parameters.
Appropriate steps were taken to ensure the accuracy of data reduction, including reducing data transfer errors in the preparation of summary data tables and maps.	→	Maintain permanent file for laboratory hardcopies of analysis reports. Minimize retyping of data and error check data entered into database, tables, maps, etc.

RPD = Relative Percent Difference
LRL = Laboratory Reporting Limit

TABLE 5

Sample Station Numbers and Descriptions
Richardson Flat Sample and Analysis Plan

Location	Media	Analytes	Location Description	
Impoundment	Soils	List 1	Tailing cover, visual with laboratory confirmation at 10% of locations. Approximately 42 locations, see Fig 5.	
Impoundment	Tailings	List 2	Tailings below cover, three test pits, discrete samples at 1' increments down to 5' bgs, see Fig. 5	
Impoundment	Surface Water	List 3	Surface water samples at RF-1,RF-2,RF-3-2,RF-4,RF-5,RF-6-2,RF-7-2,RF-8, monthly frequency, see Fig.4 for locations	
Site	Groundwater	List 3	Ground water samples on monitoring wells completed in Silver Creek alluvium, donwstream and upstream of Site.	
Site	Soils	List 2	Evaluate tailings south of diversion ditch, determine extent of tailings and impacts to diversion ditch and groundwater, see Fig 5.	
Site	Soils	List 1	Evaluate extent and nature of wind blown tailings, See Fig 6.	

List 1 Analytes: pH, As, Pb,
List 2 Analytes: pH, Ag, As,Cd,Cu, Fe, Hg, Pb, Sb, Se, Zn,CEC
List 3 Analytes: TSS, TDS, pH, hardness, Alk, Ag,Ag-d,As,As-d,Cd,Cd-d,Fe,Fe-d,Hg,Hg-d,Pb,Pb-d,Sb,Sb-d,Se,Se-d,Zn,Zn-d,Ca,K,Mg,Na,Cl,SO4,CO3,HCO3,NO2,NO3, CA/AN Bal.

APPENDICES

Site Heath and Safety Policy

Previous Site Studies

Standard Operating Procedures

Sample Chain of Custody

AEC QA/QC Manual and Certification Letters

FRONTIER GEOSCIENCES QA/QC Manual and Certification Letters

Glossary

References

United Park Health and Safety Policy
Richardson Flat Site
Park City, Utah

Site ID Number: UT980952840

Prepared for:

United Park City Mines Company
Park City, Utah

Prepared by:

Resource Management Consultants, Inc
Midvale, Utah

January 2000

Figures
Emergency Route to Hospital

Appendix
Emergency Contact Phone Numbers

1.0 INTRODUCTION

This Health and Safety Policy (HASP) is intended to protect all employees, general contractors, subcontractors, and/or visitors conducting or observing any activities under the direction of United Park City Mines Company (United Park). This HASP is intended to apply to activities taking place at the Richardson Flat Tailings Site (hereafter referred to as the Site), and covers both investigation and construction. The policy is intended to minimize potential exposures and/or accidents that may occur, and details the actions to be taken during an emergency. The HASP will establish required procedures intended to minimize exposures of United Park personnel, contractors, visitors and the surrounding community. Guidelines contained herein that are appropriate to the activities taking place at the Site will be observed at all times.

All personnel will be required to understand and observe the provisions of this plan. Any tasks associated with investigation or remediation activities on the Site must be performed in accordance with this policy, designed to ensure that employees are adequately protected from any potential chemical and/or physical hazards present at the Site. To help ensure safety compliance, all field participants and observers must read this plan and sign a certification stating that they agree to comply with the conditions of the policy. All activities conducted will be in accordance with 29 CFR part 1910, *OSHA standards for general industry.*

1.1 Site Description

The Site covers approximately 700 acres in a small valley in Summit County, Utah, located one and one-half miles northeast of Park City, Utah. The Site includes a tailings impoundment covering approximately 160 acres in the northwest corner of the Property and lies within the NW quarter of Section 1 and NE quarter of Section 2, Township 2 South, Range 4 East, Summit County, Utah.

United Park personnel will be investigating the soil and water in and around the tailings impoundment. During the course of this investigation, there exists a potential for personnel to have limited contact with tailings contained on the Site. The mill tailings present at the Site consist mostly of sand-sized particles of carbonate rock with some minerals containing silver, lead, zinc and other metals. Currently, tailings at the Site are completely covered with a layer of clean fill.

1.2 Site Activities

This HASP is intended to address the risks associated with sampling and construction activities, which will take place at the Site. During the course of investigation by United Park, personnel will be required to visit the Site in order to collect soil and water samples for chemical analysis. Personnel will also visit the Site to survey and perform other miscellaneous tasks. The procedures contained in this HASP are intended to protect

those personnel from potential hazards while carrying out their duties, and provide them with information necessary in the event of an emergency.

It is anticipated that investigations by United Park may also involve limited construction activities, including excavation and/or removal of soils. The HASP has therefore included procedures for equipment and personnel involved in construction activities at the Site.

2.0 PROJECT MANAGEMENT

Efficient implementation of this policy requires that the roles, responsibilities and scope of authority for key personnel be identified. United Park shall identify individuals responsible the following positions:

2.1 Project Manager

The Project Manager is responsible for implementation of the work plan and compliance with the HASP.

2.2 Health and Safety Manager

The Health and Safety Manager will have a thorough working knowledge of state and federal occupational safety and health regulations in addition to thorough knowledge and understanding of this policy. The Health and Safety Manager will have the authority to temporarily suspend site operations in order to ensure site safety and resume normal operations once the appropriate measures have been taken. The Health and Safety Manager will report directly to the Project Manager.

2.3 Site Manager

The Site Manager will be present during the majority of site activities and will be responsible for general site activities, supervision and enforcement of this HASP. The Site Manager will report directly to the Health and Safety Manager.

2.4 Supervisor

The Supervisor(s) will be present during all on-site activities and will report directly to the Site Manager.

Note: The aforementioned personnel may be increased, or personnel may share responsibilities dependent upon specific site conditions.

3.0 TRAINING

3.1 Off-Site Training

All full-time, part-time and short-duration workers must hold current certification of the Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hour training. Visitors must hold current certification of OSHA/HAZWOPER 40-hour training and shall be escorted at all times by an experienced and trained Site Manager.

3.2 On-Site Training

An informational training program implemented by United Park will cover on-site training.

3.3 Weekly Health and Safety Meetings - Construction

During any construction or excavation activities, the site Health and Safety Manager will conduct mandatory weekly safety meetings for all site personnel. The meetings will provide time for refresher courses, and new site conditions will be examined as they are encountered.

3.4 CPR and First Aid Training Requirements - Construction

During any construction or excavation activities, a minimum of one worker per work crew or shift shall have a current certificate of training in first aid and CPR. These workers must have appropriate training and medical surveillance to enter the Site.

4.0 MEDICAL SURVEILLANCE

4.1 Medical Surveillance - General

Medical surveillance will be obtained if personnel:

- Receive, or may have received, a possible overexposure to on-site contaminants;
- Received an injury requiring hospital or medical attention;
- Experience an unexplained or serious illness.

4.2 Medical Surveillance - Construction

A yearly physical examination shall be provided for field personnel involved with excavation of any tailings material in excess of 500 yd^3. The examination shall emphasize skin, renal, hepatic, immunological, neurological, and hematological systems, and shall include tests for liver and kidney function. If construction personnel are exposed to tailings materials on-site for thirty (30) days or more, they will participate in a medical examination program according to OSHA's lead (29 CFR 1926.65) standard.

5.0 HEALTH AND SAFETY PROTECTION

5.1 Substance Hazards

Lead, arsenic and cadmium are known to exist on the Site, and personnel should be briefed on exposure and health hazards. It is not anticipated that exposures to these substances will exceed OSHA's Personal Exposure Limit (PEL). The following table lists the primary hazards associated with significant exposure to each substance.

Lead	Toxic on inhalation and ingestion.
Arsenic	Toxic on inhalation and ingestion; skin irritant; known human carcinogen.
Cadmium	Toxic on inhalation and ingestion; suspected human carcinogen through inhalation only.

5.2 Safety Hazards

Investigation activities may expose field personnel to potential physical hazards including, but not limited to:

- Holes and ditches
- Uneven terrain
- Slippery surfaces
- Electrical equipment
- Mobile equipment
- Overhead hazards
- Underground hazards

5.3 Personal Protection Equipment - Construction

The minimum level of protection used during any construction activities is level D, requiring the following items:

- Hardhat;
- Steel-toed boots;
- Safety glasses;
- Cotton coveralls;
- Work gloves;
- Sampling gloves;
- Hearing protection, when needed.

5.4 Personal Air Monitoring – Construction

During construction activities involving contact of tailings material, personal air monitoring will be conducted to verify and document exposures to lead, arsenic, and cadmium on this project do not exceed the OSHA PEL's. Personal air monitoring will only occur when tailings are contacted in excess of 500 yd^3. If monitoring reveals exposures above an OSHA PEL, then field personnel will be upgraded to level C protection.

5.4.1 Work Practices to Reduce Employee Exposure - Construction

While performing any construction/excavation activities, work practices shall be instituted to ensure worker exposure remains below the applicable PEL. Work practices will include wetting down excavation-sites as needed throughout any excavation operation. The site safety officer will be responsible to monitor the dust control operations when needed.

5.5 Exposure to Elements

5.5.1 Heat Stress

The potential for heat stress depends on the type of protective gear being worn, the ambient temperature, and the amount of activity. Personnel will report any cases of dizziness, excessive sweating, increased respiratory rate, or pulse and are to leave the work area immediately if these conditions are noted. Work cycle lengths will be based initially on subjective input from personnel, and will be reduced and a monitoring program will be initiated if the above are noted. Work cycles will also be reduced if a pulse rate of greater than 110 is noticed during rest. Personnel with elevated rates will not return to work until the pulse has lowered to their resting rate.

Workers exhibiting signs of heat stress will have their oral temperature measured at the beginning of a rest period before liquid intake. If oral temperature exceeds 99.6° F, the next work cycle will be shortened by one-third without changing the rest period. If the oral temperature still exceeds 99.6° F at the beginning of the next rest period, the next work cycle will be shortened by another one-third. If the oral temperature exceeds 100.6° F, the worker will not be allowed to wear semi-permeable or impermeable clothing. If an employee is overcome with heatstroke or becomes unconscious, the 9-1-1 service will be called. First-aid procedures will be used for heat related conditions, as necessary. Some of the signs and symptoms of heat stress are as follows:

5.5.1.1 Heat Rash

Symptoms of Heat Rash include:

- Profuse tiny raised vesicles on the skin
- Pricking sensations during heat exposure

5.5.1.2 Heat Cramps

Symptoms of Heat Cramps include:

- Painful spasms of muscles used during work
- Onset during or after work hours

5.5.1.3 Heat Exhaustion

Symptoms of Heat Exhaustion include:

- Fatigue
- Nausea
- Headache
- Giddiness
- Clammy and moist skin
- Pale complexion
- Upon standing, fainting possible, with rapid, thready pulse and low blood pressure

5.5.1.4 Heatstroke

Symptoms of Heatstroke include:

- Hot dry skin usually red, mottled or cyanotic
- Confusion, loss of consciousness, and convulsions

Note: Heat stroke may be fatal if treatment is delayed

5.5.2 Cold Stress

During on-site activities, workers may be exposed to cold temperatures. Exposure to cold temperatures increases the likelihood and potential for disorders or conditions that could result in injury or illness. Factors leading to hypothermia and frostbite include ambient temperature, wind velocity, exposure time and insufficient cold-weather protective gear. Signs of excess cold exposure include uncontrollable fits of shivering, slurred speech, memory lapses, immobile hands, stumbling, drowsiness, and exhaustion. Treatment for these symptoms are to get the victim out of the wind and cold, remove wet clothing, supply a warm drink, and keep victim warm with blankets or clothing.

5.5.2.1 Hypothermia

The first symptoms of this condition are uncontrollable shivering and the sensation of cold, irregular heart beat, weakened pulse, and change in blood pressure. Severe shaking

of rigid muscles may be caused by a burst of body energy and changes in the body's chemistry. Vague or slow slurred speech, memory lapses, incoherence, and drowsiness are some of the additional symptoms. Symptoms noticed before complete collapse are cool skin, slow and irregular breathing, low blood pressure, apparent exhaustion, and fatigue even after rest. As the core body temperature drops, the victim may become listless and confused, and may make little or no attempt to keep warm. Pain in the extremities can be the first warning of dangerous exposure to cold. If the body core temperature drops to about 85° F, a significant and dangerous drop in the blood pressure, pulse rate, and respiration can occur. In extreme cases, death will occur.

5.5.2.2 Frostbite

Frostbite can occur, in absence of hypothermia, when the extremities do not receive sufficient heat from central body stores. This can occur because of inadequate circulation and/or insulation. Frostbite occurs when there is freezing of fluids around the cells of the body tissues due to extremely low temperatures. Damage may result, including loss of tissue around the areas of the nose, cheeks, ears, fingers, and toes. This damage can be serious enough to require amputation or result in permanent loss of movement. The potential for both heat and cold related disorders or conditions can occur in many common situations. Cold early morning temperatures can give way to warm daily temperatures, resulting in heavy perspiration within protective clothing. As temperatures cool again in the evening, the potential for cold related disorders or conditions can occur. Managers should be aware of the potential for this occurrence and should monitor workers accordingly.

5.5.3 Wind Exposure

Extreme low temperatures may not be the only element necessary to create the potential for cold exposure disorders or conditions; strong wind accompanied by cold temperatures can lead to these types of disorders or conditions. The windchill factor is the cooling effect of any combination of temperature and wind velocity or air movement. The windchill factor should be considered when planning for exposure to low temperatures and wind.

5.5.4 Logs and Reports

United Park will maintain all records required by OSHA, Worker's Compensation Insurance and similar regulations. This will include the maintenance of accident logs, the OSHA annual summary report and the posting of all prescribed notices.

6.0 SITE CONTROL

Site control will be implemented for both investigation and construction activities as needed.

6.1 Investigation

6.1.1 Work Zone

All investigatory activities, including but not limited to surveying and sampling, at the Site will take place within the work zone; this includes the tailings impoundment and the area immediately surrounding it, currently demarcated with fencing. This area will be restricted to appropriately trained personnel, and any non-approved personnel will immediately be escorted off-site.

6.1.2 Cleaning/Maintenance Area

At the entrance(s) of the work zone, an area will be provided for removal of gross contamination from both hand tools and personnel. United Park personnel and/or representatives will remove gross contamination from their boots and coveralls. Facilities will be provided for personnel to wash their hands and face as needed. At a minimum, facilities will include fresh water, soap, towels and waste receptacle.

6.2 Construction

6.2.1 Work Zone

All construction activities carried out at the Site will occur within the work zone, currently demarcated by fencing. This area poses a potential hazard and will therefore be restricted to trained workers with the appropriate personal protective equipment. Any excavation-sites will be demarcated by yellow barrier tape, if not backfilled prior to the end of each workday. An area that has been backfilled will be considered as lacking hazards, unless exposed utilities, etc. create a hazard. Such hazards will be demarcated with barrier tape.

6.2.2 Cleaning/Maintenance Area

At the entrance(s) of the work zone, an area will be provided for removal of gross contamination from both equipment and personnel. United Park personnel and/or representatives having contact with any tailings material will be required to remove gross contamination from their vehicles, equipment, boots and coveralls prior to leaving the Site. At a minimum, facilities will be provided including pressurized water, scrub tools for vehicles and equipment, and fresh water, soap, towels and waste receptacle.

6.3 General Maintenance

General cleaning maintenance is key in helping to maintain acceptable exposure levels for lead, arsenic, and cadmium. General cleaning/maintenance will be required for all equipment and facilities used by on-site as well as off-site personnel. This will include, but is not limited to a change and/or shower facility, office areas, and lunch facilities.

6.4 Equipment Safety

All mobile equipment with limited visibility to the rear shall be equipped with audible back-up alarms. If mobile equipment is operated at night, it shall be equipped with head lights and taillights. All equipment will be maintained in good condition. When the operator leaves the cab of mobile equipment, emergency brakes shall be set and any hydraulics released. If a truck is parked on an incline, it shall have the tires chocked.

When refueling, engines on all equipment shall be shut off. All mobile equipment will be supplied with a fire extinguisher with a rating of not less than 5-B rating, and the service truck will be supplied with a fire extinguisher with a rating of not less than 20-B rating.

6.5 Electrical Safety

Electrical power tools will continuously be inspected for damage. Electric tools with frayed cords or broken housings will be tagged and taken out of service.

If tools are used in wet conditions, they must be listed or labeled as double insulated. All extension cords will be of the three-wire ground type and be connected to a ground fault circuit interrupter (GFCI). If extension cords are not plugged into a permanently mounted GFCI, then the extension cord must be supplied with a waterproof GFCI. Extension cords that are spliced, worn, or frayed are not to be used. Extension cords must have the manufacturers rating on the cord and it must be legible; if it is not legible the cord must be taken out of service.

6.6 Miscellaneous Site Safety Rules

Miscellaneous Site Safety Rules include the following:

- Smoking, eating, chewing, applying cosmetics, etc. is not allowed on-site.
- A minimum of two personnel shall be on-site at all times.
- No horseplay is permitted at any time
- Vehicles used to transport personnel shall have seats firmly secured and adequate for the number of persons to be carried.
- Seat belts and anchors meeting the requirements of 49 CFR part 571 (department of transportation, federal motor vehicle safety standards) shall be installed in all motor vehicles.

7.0 DECONTAMINATION

7.1 Field Personnel

Decontamination procedures for field personnel shall be:

- Gross contamination removal from clothing and boots prior to leaving the Site.
- Wash hands and face at facility provided
- Containment of dirty coveralls.
- Launder coveralls at commercial laundry.

7.2 Equipment

The decontamination procedures for equipment contacting tailings shall be:

- Clean vehicles (inside and out) as needed prior to leaving the Site.
- Construction equipment, backhoes, loaders, dump trucks, hand tools, trailers hoses, etc contacting any tailings material will be cleaned of gross excavated soil material before leaving the Site and pressure washed upon culmination of scheduled work.
- Sampling equipment and hand tools not contacting tailings material will be cleaned of gross contamination prior to leaving the Site.

8.0 EMERGENCY RESPONSE

Accidents or potentially hazardous conditions will be handled in a manner to minimize the health risk to personnel. Accidents and hazardous conditions will be reported to the site safety officer. Prior to the start-up of this project, methods of communication will be established in order to summon emergency services in a timely manner. Supervisory personnel and the Site Safety Officer will be trained in first aid/CPR.

8.1 Emergency Route to Hospital

The emergency route to local medical facilities is shown in Figure 1 and emergency contacts with phone numbers are listed in Appendix A

8.2 Incident Command System

The Incident Command System used on this project will utilize different senior response officials depending on the nature of the incident. Front line supervisors are the initial "Senior Official" until the Project Manager or the Health and Safety Manager arrives. When emergency officials arrive, they shall become the "Senior Official".

8.3 Response Procedures

All United Park personnel will be trained in general procedures in the event of an emergency. Prior to beginning any work, personnel will be required to review the emergency procedures of this plan and ensure that all necessary equipment is ready for use in the event of an emergency. Visitors to the Site should also be briefed on these procedures.

Common forms of emergency include, but are not limited to fires, explosions, spills, sudden changes in weather, and personal illness or injury. The following emergency response procedures have been developed to help ensure a timely and efficient response to emergency situations that may arise.

8.3.1 Major and Minor Personal Injury

If field personnel are injured, the incident scene will be evaluated for immediate hazards and actions taken to eliminate those hazards. Once the incident scene is safe, the "Senior Official" will make an evaluation of the injured person. Seriously injured personnel should not be moved unless their life is in immediate danger and until a person trained in first-aid and CPR has made an assessment.

If the victim is conscious, first-aid may only be administered with the injured person's permission. If the victim is unconscious or unable to respond, then no permission is required to provide standard first aid. If no outside emergency services are needed, the

"Senior Official" will arrange for the injured person to be transported to the predetermined medical facility.

If it is determined that emergency medical services are needed, the emergency services listed in Appendix A will be contacted as soon as possible. Calling for help is often the most important action to be taken. If you are the only person with the injured employee and urgent care is needed, provide initial critical care and then contact the outside emergency services. Return to care for the victim as soon as possible.

First-aid or other appropriate actions can be administered by the initial "Senior Official" or by the victim. For injuries requiring medical treatment such as a laceration requiring stitches or a sprained ankle, the "Senior Official" shall arrange transportation to the emergency facility as noted in Figure 1. For major injuries, the "Senior Official" may administer first-aid. The "Senior Official" rendering assistance will not place themselves in a situation of unacceptable risk.

8.3.2 Fire or Explosion

In the event of a fire or explosion, the local fire department will be notified immediately. The "Senior Official" will notify the emergency services and inform them of the location, nature and identification of any hazardous materials on-site.

During the beginning stages, the closest person to the incident will take measures to extinguish the fire using a fire extinguisher or water hose. If the fire progresses beyond the beginning stages, the "Senior Official " will evacuate workers and any other occupants on the property from the immediate area and allow local fire officials to attend to the situation.

8.4 Notification and Documentation Procedures

As soon as practical following an accident/incident, the accident/incident will be documented using the appropriate report forms and the site safety officer will be notified.

8.5 On-Site Emergency Equipment

The following emergency equipment will be maintained at all work sites.

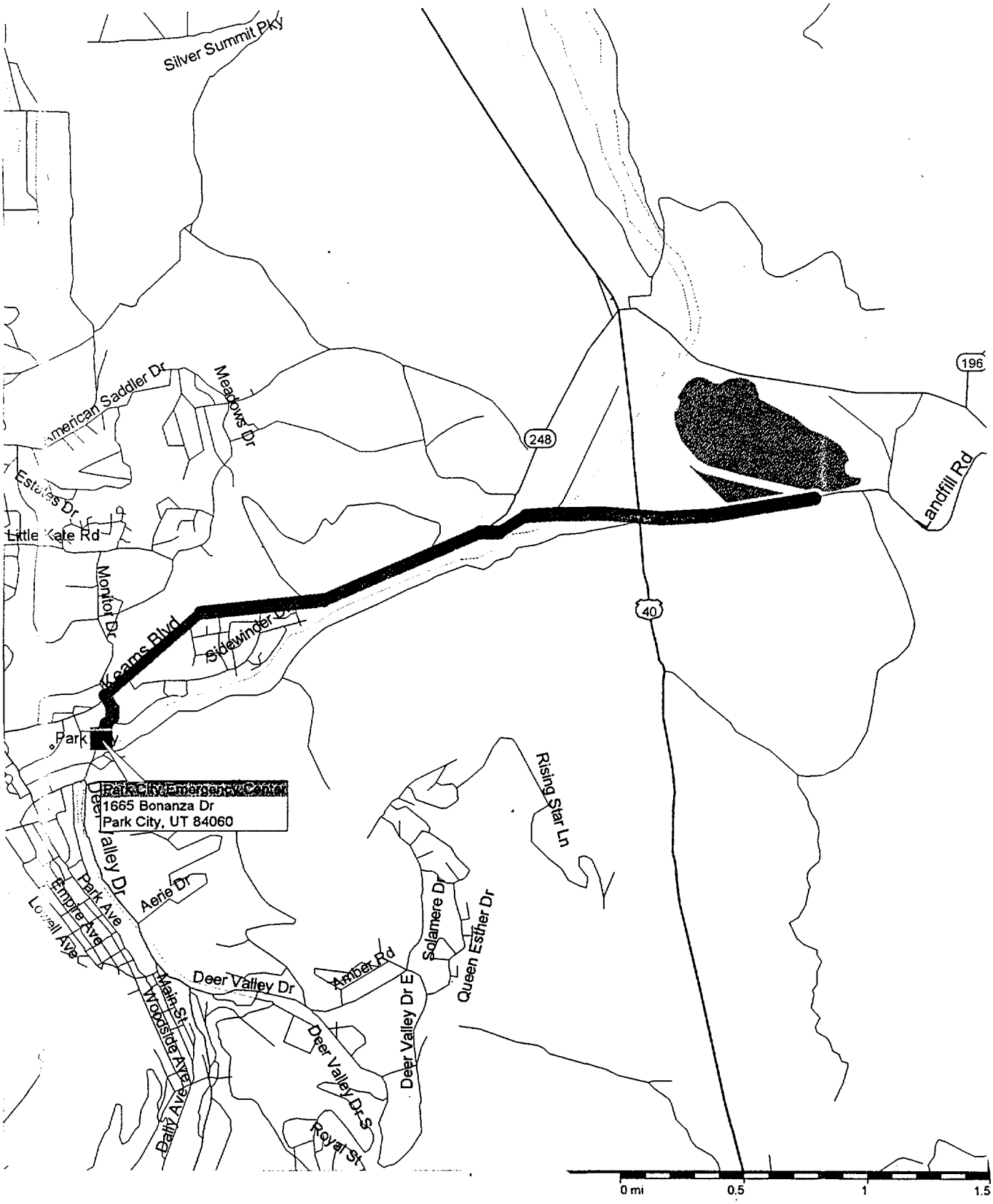
- Cellular Telephone;
- First-aid kit;
- Fire extinguisher; and
- Emergency eye wash solution.

APPENDICES

FIGURES

Appendix A – Emergency Contact Phone Numbers

Organization	Telephone
Any Emergency	**911**
Ambulance:	911
Local Police:	435-645-5500
Fire:	911
State Police:	801-576-8606
Hospital (Primary)	435-649-7640
Hospital (Secondary)	435-655-0055
Poison Control Center:	801-581-2151
Regional EPA:	800-227-8917
EPA Emergency Response Team:	800-227-8914
National Response Center:	800-424-8802
Center for Disease Control:	404-639-3311
Chemtrec:	800-262-8200
Spill Center:	978-897-6461
Site Emergency Operations Center:	801-355-2350
DOE Emergency Operations Center (National Center):	202-586-5000



N		Date :	October, 2000
		Title :	Richardson Flat Emergency Route
	RMC Resource Management Consultants, Inc.	Client :	UPCM
		Fig. No.:	Figure 1

Additional Studies Relevant to the Richardson Flat Area

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Basin, Park City, and Adjacent Areas, Summit County, Utah: State of Utah Department of Natural
Resources, Technical Publication No. 115, 84 pp.

Dames & Moore, 1973, Report of Ground Water Monitoring and Seepage Study, Tailings Pond Development, Near Park City, Utah: Consultant's report prepared for Park City Ventures Corporation, December, 1973.

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Ecology and Environment, Inc., 1993, Final Report, Richardson Flats Tailings, Summit County, Utah:
Consultant's report prepared for U. S. Environmental Protection Agency, Region VIII, Waste Management
Division, TDD #T08-9204-015 and #T08-9210-050, PAN EUTOO39SBA and EUTOO39SDA.

Pioneer Technical Services, Inc., 1993, Comments Regarding: Final Report, Richardson Flats Tailings, Summit County, Utah, Dated February 19, 1993 and Prepared by Ecology and Environment, Inc.:
Consultant's report prepared for United Park City Mines Company, December, 1993.

RMC SOP 1
STANDARD PROCEDURES FOR COLLECTION OF SURFACE WATER SAMPLES

This SOP describes the procedures that will be used for collection of water samples. The procedures will ensure that samples are collected and handled properly and that appropriate documentation is completed.

Sampling Equipment:

- Log forms / Field notebook / COC
- Sample containers
- Tape measure
- Direct reading instruments (if necessary)
- Tool chest
- Disposable sampling gloves

Procedure

Sample bottles will remain sealed until the water sample is collected. At that time, the bottle lid will be removed and placed, top down, in an appropriate place. The sample bottle will be placed under the flow of water until the full volume of the container is filled; any overflow of the sample container will be kept to a minimum. The sample cap will then be placed under the flow and the collected water will be poured into the sample bottle as the cap is replaced on the sample bottle. All surface water samples will be collected in accordance with containers, volumes, preservatives, temperatures and holding times as outlined in Table 2.

Dissolved Metals Analysis

Surface water samples collected for analysis of Dissolved (D) Metals will be a minimum volume of 500 ml, collected in a poly or glass container. The samples will be field filtered, the sample will be preserved with 2 ml of NO_3, sufficient to bring the sample to pH <2.

Total Metals Analysis

Surface water samples collected for analysis of Total (T) Metals will be a minimum volume of 500 ml, collected in a poly or glass container, and preserved with 2 ml of NO_3, sufficient to bring the sample to pH <2.

Cations/Anions

Total Suspended Solids

Labeling

Each soil sample will be labeled with the following information:

- Sample identification;
- Project number/name;
- Date/time collected; and
- Samplers initials.

Demobilization

After decontamination, sample equipment will be stored in the appropriate, clean containers. Any equipment that suffers damage or excessive wear while conducting sampling will be labeled and reported to the equipment manager for the necessary maintenance, repair and/or replacement.

SOP 2a
STANDARD PROCEDURES FOR COLLECTION OF SURFACE SOIL SAMPLES

This SOP describes the procedures that will be used for sampling surface soils from ground surface to a maximum of 18 inches below surface. Samples will be collected with a decontaminated shovel or hand auger/probe. Specific soil sampling locations will be determined from the project work plan.

Sampling Equipment:

- Hand Auger/Probe (if necessary)
- Shovels
- Log forms / Field notebook / COC
- Sample containers
- Stainless steel sample spoons
- Tape measure
- Direct reading instruments (if necessary)
- Tool chest
- Disposable sampling gloves

Decon Equipment:

- 5 gallon buckets
- Alconox
- Scrub brushes
- Distilled water
- Paper towels

PROCEDURE:

Discrete Samples

If significant vegetation, rocks, or debris prevent collecting the surface samples then the upper 2-3 inches of soil will be scraped away from the sample location with a shovel or stainless steel spoon. The underlying soil will then be collected and placed into sample containers with a stainless steel spoon or gloved hand. Composite samples will be homogenized as described below. Coarse grained soils, gravel and rock fragments will be removed wherever possible.

Composite Samples

Composite samples will be collected (as described above) by placing sub samples into a stainless steel mixing bowl or a clean plastic bag, or by hand with new, clean sampling gloves. The sample will be homogenized with a stainless steel spoon or gloved hand. The homogenized soil will be packaged in a laboratory-supplied sample container, labeled and placed in a cooler to maintain temperature.

Labeling

Each soil sample will be labeled with the following information:

- Sample identification;
- Project number/name;

- Date/time collected; and
- Samplers initials.

Demobilization

After decontamination, sample equipment will be stored in the appropriate, clean containers. Any equipment that suffers damage or excessive wear while conducting sampling will be labeled and reported to the equipment manager for the necessary maintenance, repair and/or replacement.

SOP 2b

HAND AUGER SOIL SAMPLING

Introduction

Hand auger equipment will be used for collecting shallow soil samples to approximately 15 feet below ground surface. This SOP describes the procedures for collecting soil samples using hand auger equipment.

Equipment:

- Hand augers
  - Clay auger barrel
  - Sand auger barrel
  - Extension rods
  - T handle
- Two crescent wrenches
- Rock bar
- Decon supplies
  - Buckets
  - Alconox detergent
  - Distilled water
  - Scrub brush
- Tape measure
- Direct reading instruments (if necessary)
- Log forms/field notebook
- Munsell color chart
- Sample containers
- Surface patching supplies, if necessary (asphalt patch/post mix)
- Screw driver and hammer
- Stainless steel bowl or sealable plastic bags for compositing

Preliminaries

All boring locations will be determined using the project specific Work Plan. Arrangements will be made for the location of underground utilities using Blue Stakes. A private locating service will be used for utilities that are not covered by Blue Stakes.

Procedures

The borehole will be advanced using the clay bucket for fine-grained soils and the sand bucket for coarse-grained soils. Each auger bucket of soil will be screened with the appropriate direct reading instrument and readings will be recorded on the soil boring log. Soil samples selected for laboratory analysis will be packed in a laboratory supplied container so that no headspace is present. Each sample will be labeled with the following information:

- Sample identification
- Project name
- Project number
- Date and time collected
- Sampler's initials

This information above should also be recorded in the field notebook.

Decontamination

All sampling equipment will be decontaminated between sample locations by washing with an Alconox detergent solution followed by a triple rinse of deionized water. After decontamination, sample equipment will be stored in a clean area and placed into their appropriate storage containers after use. Sample personnel will change into a new pair of chemical resistant gloves between samples and the previously worn gloves will be discarded.

Demobilization

After decontamination, sample equipment will be stored in the appropriate storage containers. If any equipment is damaged while conducting soil sampling, the damaged equipment will be labeled and reported to the equipment manager for maintenance or replacement.

SOP 2b

GEOPROBE SAMPLING

Introduction

Geoprobe™ sampling equipment will be used to advance shallow soil borings (30 feet or less) to collect soil and groundwater samples and for sites where access restrictions prevent mobilization of a drill rig. Standard operating procedures for geoprobe soil and groundwater sampling are described below.

Preliminaries

Geoprobe sample locations will be marked or staked in the field and coordinated with the RMC project manager and, if necessary, the client project manager. Blue Stakes utility clearance will be requested for each boring location prior to geoprobe sampling. Borings will be located at least two feet from marked underground utilities.

All sampling equipment will be decontaminated prior to mobilizing to the site. This equipment includes all geoprobe rods, geoprobe samplers, and stainless steel bowls and spoons.

Geoprobe Equipment and Procedures

Soil borings will be advanced and sampled using a geoprobe hydraulic hammer mounted to a truck, van, fourwheeler, or small tractor. Each borehole will be started by hydraulically hammering a 3 foot length of 1inch outside diameter steel drill rod with a disposable pointed steel end point into the ground. The borehole will be advanced in 3 foot increments by adding 3 foot sections of flush threaded drill rod to the drill stem already in the ground. No lubricants or additives will be used while advancing geoprobe borings.

Soil Sampling Equipment

The following equipment will used to conduct soil sampling:

- Geoprobe core sampler (supplied by the geoprobe contractor)
- New polybuterate sample liners (supplied by the geoprobe contractor)
- New sample liner end caps (supplied by the geoprobe contractor)
- Chemical resistant gloves
- Appropriate personal protection equipment according to the HASP
- Sealable plastic bags
- Sample labels
- Laboratory supplied glass soil sample jars and labels (optional)
- Stainless steel putty knife
- Stainless steel bowl and spoon
- Photoionization detector (PID)
- Cooler and ice
- Munsell color chart
- Unified Soil Classification System (USCS) chart

Soil Sampling

Samples will be collected as specified in the site specific sampling plan. At a minimum, soil samples will be collected at 5 foot intervals if lithologic information is needed. Each soil sample will be collected in a 2 foot long brass core sampler. The sampler will be attached to the drill rod, lowered to the sample interval, opened, and then hydraulically hammered two feet into the subsurface.

Groundwater Sampling

To facilitate the collection of groundwater samples at sites where the water table is penetrated, a temporary well point will be installed in the geoprobe borehole. After the water table has been encountered, the borehole will be advanced at least three more feet to ensure adequate sample volume. The well point may consist of either a three foot long stainless steel screen, attached to polyethylene tubing, or a length of 3/8inch polyethylene tubing with perforations in the bottom 3 feet. New tubing and well screens will be used for each well point. After approximately 15 minutes, a peristaltic pump will be attached to the tubing to obtain groundwater.

Groundwater samples collected for metals analysis will be filtered using inline filters attached to the outlet tubing of the peristaltic pump or with NalgeneTM handpump filters.

Boring Abandonment

After all soil and groundwater samples have been collected, each soil boring will be backfilled with granular bentonite. Borings that were drilled through asphalt or concrete will be backfilled with granular bentonite to within six inches of the ground surface and the asphalt and concrete cores will be restored.

Demobilization

After the equipment has been rigged down and loaded, the site will be cleaned and restored as close to its original condition as possible. All sampling equipment will be decontaminated prior to mobilizing to the next geoprobe sample location.

SOP 3a

HOLLOWSTEM AUGER DRILLING AND SOIL SAMPLING

Introduction

Hollowstem auger drilling techniques will be used to advance intermediate depth borings of 100 feet or less. Standard operating procedures for hollowstem auger drilling and soil sampling are described below.

Preliminaries

Final soil boring locations will be marked or staked in the field and coordinated with the RMC project manager and, if necessary, the client project manager. Blue Stakes utility clearance will be requested for each drilling location to identify any subsurface utilities prior to drilling and sampling. If required, drilling and/or monitoring well permits will be requested by supplying the appropriate forms to the corresponding regulatory agency.

Boring locations will be located the following distances from overhead power lines:

Power Lines Nominal System (kv)	Minimum Required Clearance (ft)
0-50	10
51-100	12
101-200	15
201-300	20
301-500	25
501-750	35
751-1000	45

All drilling and sampling equipment will be decontaminated with a steam cleaner prior to drilling. This equipment includes all drill pipe, auger flights, splitspoon samplers, brass sleeves, stainless steel bowls and spoons, tools, and nonpackaged well screen and casing. Steam cleaning will be conducted after placing equipment, tools, and nonpackaged screen and casing on racks or sawhorses to keep them off the ground. After steam cleaning is completed, the equipment will remain off the ground until it is used. Borings will be located according to the site specific work plan. No borings will be drilled within 5 feet of marked underground utility lines or within 10 feet of active overhead power lines. Boring locations will be adjusted, as necessary.

Drilling Equipment and Procedures

A truck mounted hollow stem auger drill rig will be used to drill borings of 100 feet or less. Augers will be sized to accommodate the well casing diameter, if a well is to be installed in the borehole. A center plug will be used to prevent liquefied sands from entering the inside of the auger string as the borehole is advanced. No lubricants, circulating fluid, drilling muds, or other additives will be used during drilling.

Soil Sampling Equipment

The following equipment will be used to conduct soil sampling:

- Splitspoon samplers and sand catcher (supplied by the driller)
- Chemical resistant gloves
- Appropriate personal protection equipment according to the HASP
- Sealable plastic bags
- Brass sleeves, end caps, and Teflon tape
- Sample labels
- Laboratory supplied glass soil sample jars and labels (optional)
- Stainless steel putty knife
- Stainless steel bowl and spoon
- Photoionization detector (PID)
- Cooler and ice
- Munsell color chart
- Unified Soil Classification System (USCS) chart
- Decontamination equipment

All sampling equipment will be decontaminated prior to mobilizing to the site.

Soil Sampling Procedures

Samples will be driven at intervals specified in the work plan. At a minimum, samples will be driven at 5 foot intervals, if lithologic data is needed. A sand catcher will be placed at the end of the sampler so that unconsolidated soils are not lost as the sampler is retrieved from the borehole. The sampler will be advanced by blows from a 140-pound downhole hammer. The number of blows required to drive the sampler 6 inches will be recorded on the Soil Boring Log Form.

Each site-specific sampling plan will identify the appropriate sample containers used to collect soil samples. In general, brass sleeves will be used for samples being analyzed for volatile and semi-volatile organic compounds. If sample analytes do not include volatile or semi-volatile organic compounds, laboratory supplied glass jars may be used. Otherwise, samples should be submitted in brass or plastic (for inorganic analyses) sleeves. Head space readings will be collected from adjacent soils.

Sleeves in the sampler will be separated using a stainless steel putty knife and the soil between the sleeves will be carefully cut so that the soil within the sleeve is flush at each end. Each sleeve will be sealed so that there is little or no headspace between the sample and the Teflon tape. Each sleeve will be labeled with the sample identification and immediately placed in an iced cooler to maintain a temperature of 4°C. The remaining sample(s) will be used for soil classification.

Soil Boring Abandonment Procedures

Soil borings not used for vapor probe or well installations will be backfilled. If water is not encountered in the boring, the boring will be backfilled with drill cuttings. If water is encountered, the saturated portion of the boring will be backfilled with granular bentonite. Cuttings will be used to backfill the remainder of the boring. Borings that were drilled through asphalt or concrete will be patched to match existing conditions.

Storage and Disposal of Drill Cuttings

Drill cuttings and unused soil samples will be containerized in labeled 55 gallon drums and stored in an area that will not disrupt site activities. At a minimum, each drum label will contain the following information:

- Site identification
- Soil boring identification
- Depth interval
- Date drilled
- Name of project manager

The final disposition of the soil cuttings will depend on soil analytical results and contract specifications.

Demobilization

After the site has been cleaned and restored as close to its original condition as possible, the drill rig will be moved so that the plastic sheeting can be removed. All drilling and sampling equipment will be decontaminated with a steam cleaner prior to drilling and sampling the next soil boring.

SOP 3B
STANDARD PROCEDURES FOR MONITORING WELL DEVELOPMENT

This SOP describes the procedures that will be used for developing monitoring wells after installation activities have been completed. Well development ensures that drilling fluids and/or sand pack materials are removed from the well prior to sampling and that water from the aquifer enters the well as designed.

Equipment:

- Decontaminated pump/bailer or surge block
- Field measurement equipment (pH and conductivity meters, temperature probe0
- Water level probe
- Total depth probe
- Distilled water
- Field notebook
- Clean new twine

Decontamination Equipment

- 5 gallon buckets
- Alconox
- Scrub brushes
- Distilled water
- Paper towels

Procedure

After the monitor well has been installed the well will require development to ensure that all contaminants introduced during installation are removed and that water entering the well is representative of the aquifer.

Measure total depth of well with sounding device, measure standing water level and determine well bore volume according to procedures outlined in SOP 3c.

Purge three (3) well volumes of water from the well and measure pH, conductivity and temperature from the 3rd well volume. Continue to purge the well until there are three consecutive readings from the field measurements that have similar values. The water should be clear and turbidity low and pH, conductivity and temperature should stabilize when the well is properly developed.

Note the water level, total depth, well bore volume, total volume of water purged from the well and the field readings in the field notebook.

Decontamination

Clean well development equipment according to procedures outlines SOP 6.

Demobilization

After decontamination, sample equipment will be stored in the appropriate, clean containers. Any equipment that suffers damage or excessive wear while conducting sampling will be labeled and reported to the equipment manager for the necessary maintenance, repair and/or replacement.

SOP 3C
STANDARD PROCEDURES FOR GROUNDWATER SAMPLING

This SOP describes the procedures that will be used for collecting groundwater samples. Samples will be collected with a new disposable bailer and/or a decontaminated downhole pump. Specific monitoring well locations will be determined from the project work plan.

Sampling Equipment:

- Water level probe
- Distilled water
- Field notebook
- COC
- Sample containers
- Disposable bailers
- Clean new twine
- Downhole pump
- Preservatives
- Coolers
- 0.45 um filter apparatus with inert filters

Decontamination Equipment

- 5 gallon buckets
- Alconox
- Scrub brushes
- Distilled water
- Paper towels

PROCEDURE:

Unlock and open the well, obtain a water level by inserting a decontaminated water level probe into the well and measuring the standing water surface to an established datum point on the top of the well head. The established datum point can be installed by using a file to insert a notch in the PVC casing.

Purge the well with appropriate water removal device (decontaminated bailer/pump or disposable bailer). A total of three well bore volumes of water are normally removed.

Determine the well volume by the following formula:

$$V \text{ in gallons} = \pi r^2 h \times 7.48$$

Where $\pi = 3.12$

r^2 = radius of well casing converted to feet

and h = Water level – total depth of well (determined from drillers log or previous well sounding)

Pump or bailer discharge during purging is directed to a bucket or container to determine purge rate.

Samples are collected after a sufficient purge volume is withddrawn. Bottles are filled directly from discharge from the well or from another clean container. Considerable care should be take to minimize entertainment of air.

After the bottles are filled, the appropriate preservatives are added, if required. If filtration is required, then this step is completed and the filtered water placed in the sample bottles.

If a bailer is used, care must be taken to minimize turbulence and entrainment of air in the samples.

Labeling

Each soil sample will be labeled with the following information:

- Sample identification;
- Project number/name;
- Date/time collected; and
- Samplers initials

Decontamination

If cross contamination of sampled wells is a potential problem, the following procedure should be followed:

1. Decontaminate equipment according to SOP 6.
2. Design sampling to proceed from best quality water to the poorest quality water.
3. Rinse the pumping apparatus or bailer between holes if well yields are too low to sufficient water to purge the pump, water hose or bailer.
4. Use a one disposable bailer for both purging and sampling per well.

Demobilization

After decontamination, sample equipment will be stored in the appropriate, clean containers. Any equipment that suffers damage or excessive wear while conducting sampling will be labeled and reported to the equipment manager for the necessary maintenance, repair and/or replacement.

SOP 4
STANDARD PROCEDURES FOR COLLECTION OF STREAM SEDIMENT SAMPLES

This SOP describes the procedures that will be used for sampling stream sediment to a maximum of 18 inches below surface. Samples will be collected with a decontaminated shovel or hand auger/probe. Specific soil sampling locations will be determined from the project work plan.

Sampling Equipment:

- Hand Auger/Probe (if necessary)
- Shovels
- Log forms / Field notebook / COC
- Sample containers
- Stainless steel sample spoons
- Tape measure
- Direct reading instruments (if necessary)
- Tool chest
- Disposable sampling gloves

Decontamination Equipment:

- 5 gallon buckets
- Alconox
- Scrub brushes
- Distilled water
- Paper towels

PROCEDURE:

Discrete Samples

Sediment samples will be collected from streambeds with standing water or slow flow rates such that there will be no significant impact while sampling. Vegetation, rocks, and/or debris will be scraped away from the sample location with a shovel or stainless steel spoon. The underlying sediment will then be collected and placed into sample containers with a stainless steel spoon or gloved hand. Composite samples will be homogenized as described below. Coarse grained soils, gravel and rock fragments will be removed wherever possible.

Composite Samples

Composite samples will be collected (as described above) by placing sub samples into a stainless steel mixing bowl or a clean plastic bag, or by hand with new, clean sampling gloves. The sample will be homogenized with a stainless steel spoon or gloved hand. The homogenized soil will be packaged in a laboratory-supplied sample container, labeled and placed in a cooler to maintain temperature.

Labeling

Each soil sample will be labeled with the following information:

- Sample identification;
- Project number/name;
- Date/time collected; and
- Samplers initials.

Demobilization

After decontamination, sample equipment will be stored in the appropriate, clean containers. Any equipment that suffers damage or excessive wear while conducting sampling will be labeled and reported to the equipment manager for the necessary maintenance, repair and/or replacement.

SOP 5
SAMPLE HANDLING AND DOCUMENTATION

Introduction

This section describes the handling and documentation procedures that will be used once soil and water samples are collected. The procedures will ensure that samples are handled properly and that appropriate documentation is completed.

Sample Handling

All samples will be promptly placed in an iced cooler to maintain a temperature of 4°C. Typically, samples selected for chemical analysis are delivered at the end of each day to the analytical laboratory. If they are not submitted to the laboratory on the same day collected, they will be stored in a refrigerator in a locked sample storage room at RMC's office until delivery to the laboratory.

Documentation

Sample Identification and Labeling

Soil samples will be labeled in such a way as to identify the area from which they were collected and the depth. For example, the first sample collected from profile C from a depth of 3 feet will be identified as "Ca@3.0-3.5'." Groundwater samples will be labeled with their well designations, e.g., "MW1." Duplicate samples should always be labeled so that the laboratory cannot tell they are a duplicate (i.e., as a "blind duplicate"). For example, a duplicate of well "MW1" could be labeled "MW1A," if there are no actual wells with this designation at the site.

Each sample sleeve or sample container will be immediately labeled with the following information:

- Project name
- Project number
- Sample identification
- Sample depth
- Date and time collected
- Preservative used
- Filtered or unfiltered (for water samples)
- Sampler's initials

This information will also be recorded in the field notebook.

Chain of Custody

COC documentation will begin in the field for each sample submitted to the laboratory and will also be maintained by laboratory personnel. Samples that are submitted to AEC will use the COC provided by AEC. A COC for each sampling event will be completed and will accompany each sample batch to the analytical laboratory. Sample custody means that all samples will remain in the possession or observation of the sampler at all times, or in a locked facility until delivery to the analytical laboratory. A sample COC form is provided in Appendix D.

Field Book

RMC field personnel will maintain a field logbook to record all field activities. The field logbook will be a weather-resistant bound field book. All data generated during the project and any accompanying comments will be entered directly into the logbook in indelible ink; any corrections will be made with single line-out deletions. At no time will any pages be removed from the field logbook.

Each day's field activities will be documented, including the following minimum information:

- Date of field activity;
- Time of field activity;
- RMC field personnel's initials;
- Project name;
- Project number;
- Date and time samples were collected;
- Identification of samples collected;
- Total number of samples collected per sampling event;
- Total number of samples collected from each sample location;
- Physical description of samples;
- Preservatives used for samples;
- Filtered vs. Unfiltered samples (water);
- Weather conditions;
- Description and date of any photograph(s) taken.

Sample Tracking

Samples will be logged in on a sample tracking form on a daily basis. The tracking form will be used to maintain a record of the samples collected and which samples were submitted for laboratory analysis. The logbook will provide a unique, six digit alphanumeric identifier that will be assigned to each sample collected. All samples collected will be assigned an identifier number, regardless of that samples' submission to a laboratory. The next available chronological number in the sample logbook will determine the identifier, and this number will be cross referenced with a sample description number, assigned in the field.

The sample logbook will be a covered, bound journal with non-removable pages. At no time will any pages be removed from the sample logbook.

All entries into the sample logbook will be made in indelible ink; and all corrections shall consist of initialed, line-out deletion. Data contained therein will include:

- Unique identifier number;
- Date;
- Project number;
- Sample description number;
- Sampler initials;

SOP 6
STANDARD PROCEDURES FOR DECONTAMINATION

This SOP details the decontamination protocols for sampling equipment. In order to reduce the risk of transferring materials from one sample site to another, and to assure that there is no cross-contamination of samples, the following procedures will be used.

DECONTAMINATION PROCEDURES:

RMC uses the following decontamination procedure for equipment:

Gross contaminant removal

This step involves scrubbing the equipment using an Alconox and water solution and a stiff scrub brush. The scrubbing will continue until all visible contaminants are removed from the equipment. This water will be changed as necessary.

Clean detergent wash

This step involves using a clean volume of Alconox and water solution. Equipment will be washed in this solution once all gross contaminants have been removed during Step 1. This solution will also be changed as necessary.

Clear water rinse

This step involves rinsing the equipment in clear, potable water. This water will be changed as necessary to maintain its purity.

Distilled water rinse

Distilled water will be used as a final rinse for all decontamination procedures. The water will be poured from a new container, or sprayed from a suitable container or the equipment will be submerged in a suitable container. Decontamination (equipment) blanks will be collected as required in the SAP.

AEC LABORATORIES

Laboratory Services Request Form

I. CLIENT INFORMATION

Client Name: _____

Client Address: _____

Client Phone: _____

Client Fax: _____

SEND REQUESTS TO:

AEC LABORATORIES
3422 South 700 West
Salt Lake City, UT
84119
Your Customer Service Representative is:
Maureen Ottley
Phone # (801) 261-1426
Fax # (801) 264-9838

II. ACCOUNT INFORMATION

Account Name: _____

Account Address: _____

P.O. No: _____

III. REPORT INSTRUCTIONS

Report Results To: _____

Report Address: _____

Please Forward Results By: US Mail ( ) Fed Ex ( ) Fax ( ) Other _____

Services Requested below are required no later than _____ (date)

IV. TYPE OF SERVICE REQUESTED

Please analyze the enclosed environmental samples for:

Lab Use Only Lab No.	Field Sample No./Description	Sampling Date & Time	No. of Cont.	Analysis Requested

Please send the following supplies:

( ) Laboratory Request Forms ( ) Sampling Media (please specify) _____

( ) Other

V. CHAIN OF CUSTODY RECORD

Dispatched by:	Date	Time	Courier Co. Name
Relinquished by:	Date	Time	Airbill #
Received by:	Date	Time	Custody Seal Intact?
Received for lab by:	Date	Time	Yes No

Arizona Department of Health Services

ENVIRONMENTAL LABORATORY LICENSE

Issued to:

Laboratory Director: GARY STANGA
Owner/Representative: GARY STANGA, REPRESENTATIVE

ASARCO/AEC LABORATORY

AZ0599

is in compliance with Environmental Laboratory's applicable standards for the State of Arizona and maintains on file a List of Parameters for which the laboratory is certified to perform analysis.

PERIOD OF LICENSURE FROM: 01/20/1999 TO 01/20/2000

GREAT SEAL OF THE STATE OF ARIZONA 1912 ORAT DEUS

Wynand H. Nimmo, M.T., Chief
Office of Laboratory Licensure,
Certification & Training

The American Industrial Hygiene Association

is proud to acknowledge that

ASARCO

Salt Lake City, Utah

has fulfilled the requirements for and has been formally recognized by AIHA
and is technically competent to perform the analyses listed in the following

SCOPE OF ACCREDITATION

INDUSTRIAL HYGIENE
Originally Accredited: 06/01/74

_X_ Metals
___Asbestos PCM
___Organic Solvents
_X_ Silica
___Asbestos PLM
___Diffusive Samples

ENVIRONMENTAL LEAD
Originally Accredited: 04/30/96

_X_ Paint Chips
_X_ Dust Wipes
_X_ Air
_X_ Soil

ENVIRONMENTAL MICROBIOLOGY

___Bacteria
___Fungi

The above named laboratory agrees to perform all analyses listed above in the scope of accreditation according to applicable policy requirements and acknowledges that continued accreditation is dependent on successful participation in the appropriate proficiency testing programs. This laboratory may be contacted to verify the current scope of accreditation, proficiency testing performance and accreditation status. Accreditation by AIHA is not a guarantee of the validity of the data generated by the laboratory.

Laboratory # 101578
Certificate # 003

IH Accreditation Expires: 04/30/02
Lead Accreditation Expires: 04/30/02

Christine A. Kearney
Christine A. Kearney
Chair, Analytical Accreditation Board

James R. Thornton
James R. Thornton, CIH, CSP
President, AIHA

ASARCO/AEC

QUALITY ASSURANCE MANUAL

LABORATORY QUALITY ASSURANCE PROGRAM

Reviewed _____ 1-23-00
Laboratory Coordinator

Approved _____ 1-28-00
Laboratory Manager

LABORATORY QUALITY ASSURANCE PROGRAM

Attachments

INTRODUCTION

Quality assurance has always been an important part of laboratory operations at ASARCO Inc./AEC. The following program describes the quality control procedures designed specifically to meet or exceed EPA, OSHA and various states requirements for an environmental chemistry laboratory. The program addresses the following areas: I) Goals and laboratory quality control policy; II) Personnel and training; III) Sample custody, sampling techniques and preservatives; IV) Sample receipt and log-in procedures; V) Flow of samples through the lab; VI) Analytical methodology and instrumentation; VII) Quality control and performance requirements VIII) Data reduction and validation; IX) Analytical reports and other deliverables, and; X) Standard operating procedures. The quality assurance manual is available to all personnel and is located in the supervisor's office.

I. GOALS AND LABORATORY POLICY

The purpose of the ASARCO/AEC Quality Assurance Program is to insure that all data generated and processed is scientifically valid and of known precision and accuracy. It is the policy of the laboratory to meet, as a minimum, all of the criteria set forth in this program or the method specific QC criteria and to insure that approved procedures and QA data are satisfactorily documented. The Quality Assurance manual is reviewed and approved on an annual basis by laboratory management. The effectiveness of the program is measured by means of a systems audit conducted on an annual basis by the QA coordinators. A written report of the audit findings is provided to the Analytical Services Manager. In addition, quarterly quality assurance update reports are prepared by the QA coordinators and submitted to the Analytical Services Manager.

II. PERSONNEL AND TRAINING

ASARCO field service staff, technicians and outside consulting field service personnel operate independently of the laboratory. These individuals consult with laboratory personnel and staff environmental scientists on issues such as sample volume requirements, containers and methods of preservation.

All laboratory personnel participate in an extensive on the job training program tailored specifically to the individual chemical analysis. This in-house training consists of acquiring an in-depth understanding of the appropriate methodology (eg: EPA, NIOSH and OSHA

procedures) and applying these procedures to synthetic standards, standard reference materials and various other check samples prior to the analysis of unknowns. Each analyst is also required to attend laboratory safety training seminars on a quarterly basis. In addition, analysts are encouraged to attend training seminars conducted by analytical instrument manufacturers. Training records are kept on file in the manager's office. An organizational chart and laboratory personnel responsibilities forms can be found in attachment #1.

III. SAMPLING TECHNIQUES, PRESERVATION AND SAMPLE CUSTODY

Samples are taken, labeled, preserved and prepared for shipment by qualified personnel usually under the direct supervision of the on-site environmental scientist using the EPA approved procedures listed in 600/4-79 Revised 1983 and SW 846 Third Edition; NIOSH Manual of Analytical Methods, Third Edition; and the OSHA Manual of Analytical Methods. Specific chain of custody procedures are followed utilizing the form included as attachment #2.

IV. SAMPLE RECEIPT AND LOG-IN PROCEDURES

The samples are shipped by common carrier, next day service in appropriate shipping containers such as insulated ice chests. The samples are sent to one of the following individuals:

Ms. Maureen Ottley
Customer/Systems Support Rep.
c/o ASARCO Incorporated
3422 South 700 West
Salt Lake City, Utah 84119

Ms. Jodie Haynes
Customer/Systems Support Rep.
c/o ASARCO Incorporated
3422 South 700 West
Salt Lake City, Utah 84119

Upon arrival, the shipment is inspected for completeness by the sample custodian. Chain-of-custody forms are signed as evidence of receipt and accompany samples and login/chain-of-custody work sheets while in the laboratory. The samples are then individually logged into the ASARCO Laboratory Information Management System (LIMS).

The log-in program assigns a unique lab number to each sample and prints login/chain-of-custody work sheets for each batch of samples with all pertinent information (see attachment #3). The samples are then logged into a hardbound logbook listing the computer assigned batch number, client, date of receipt, the number of samples in the batch and the matrix (see attachment #4). The condition of the shipping and sample containers are noted on the log-in checklist along with preservation parameters (see attachment #5). Field personnel are notified immediately of any inconsistencies with the chain-of-custody forms or problems regarding the condition of the sample containers or sample preservation.

V. FLOW OF SAMPLES THROUGH THE LAB

The login/chain-of-custody work sheets are given to the analyst(s) assigned to the project along with the corresponding samples. Samples are analyzed in accordance with the methods listed in Section VI of this manual. The samples are kept either in a locked refrigerator (if appropriate) or in the custody of the analysts while they are being worked on. All necessary sample and analytical information is logged in ink into a hardbound laboratory workbook (see attachment #6). This may include raw analytical data, graphs, calibration curves, quality control information, sample preparation and/or digestion procedures and any comments. All calculations such as adjustments for dilutions or concentrations, unit changes, etc. are made in this book. Any corrections are made by drawing a single line through the entry, and placing the revised entry to the side. The correction is initialed and dated. Unused portions at the bottom of a page are to have a single line extending from the last entry to the bottom of the page. Upon completion of analyses the sample and quality control data are logged into the LIMS by the analyst and a final report is generated. Water samples and digestates are stored for approximately two months after the final report has been sent. Miscellaneous and solid samples (eg. soils, solid waste, filters, etc.) are stored indefinitely. Samples for disposal are disposed of in accordance with all local, state and federal regulations.

VI. ANALYTICAL METHODS AND INSTRUMENTATION

The procedural and instrumentation manuals are available to the analyst in the supervisor's office at any time. For projects requiring contract laboratory protocol, the CLP ILM03.0 is followed. Other frequently used references are the EPA's "Methods for Chemical Analysis of Water and Wastes", 6009/4-79 Revised 1983, "Test Methods for Evaluation of Solid Wastes", SW846; "Standard Methods for

Water and Wastewater" 19th Edition and the NIOSH Manual of Analytical Methods. Methods are thoroughly tested using matrix matched standard reference materials or other materials of known composition to insure accurate and precise results before testing of unknowns is conducted.

The analytical instrumentation is operated in accordance with the manufacturer's guidelines to obtain the desired sensitivity. One example of this would be the use of the Perkin-Elmer "cookbook" for samples analyzed by atomic absorption spectrophotometry. Method detection limits are compiled annually and are included as attachment #7. Instrument standards are used on a daily basis to determine response and calibration of the instruments. These standards are traceable to high purity stock material utilizing a unique numbering system and documented in a hardbound logbook (refer to section VII). All calibration information is documented in the analyst's workbook and available for review.

Instrumentation maintenance records and service agreements are kept on file are included as attachment #8. Operating and routine maintenance SOP's are are in the ASARCO Laboratory Operations manual and on the company's intranet. Calibration and maintenance procedures are documented for support equipment such as balances and micro pipettes. Defective equipment is removed from service until repaired.

Instrument detection limits and linear dynamic ranges are determined in accordance with method specific requirements.

VII. QUALITY CONTROL AND PERFORMANCE REQUIREMENTS

Following is a summary of the ASARCO laboratory QC program:

1. Instrument Calibration and Acceptance Criteria

For atomic absorption spectrophotometry, a blank and three standards in graduated amounts must be used. Standards absorbance values will be recorded and a correlation coefficient of .995 or better must be achieved. At least two standards must be used for ICP calibration. One of the standards must be a blank. Interference check samples (ICS's) are performed daily and must be within + or - 20%. Calibrations will be conducted daily and each time the instrument is set up. Initial calibration verification (ICV) is conducted with an independent reference standard immediately after instrument calibration and must be within + or - 10%.

Continuing calibration verifications are conducted at a frequency of 1 in 10 and also must fall within + or - 10%. Initial calibration blanks (ICB's) and continuing calibration blanks (CCB's) are conducted at the frequency as the ICV's and CCV's, and are to fall within + or - the reported limit of detection.

2. Quality Control Samples

The table on the following page summarizes the type and frequency of QC samples normally used to validate. Also included are control limits and corrective action procedures.

The analysts are largely responsible for monitoring trends and trouble shooting problems with laboratory supervision in the role of reviewing the program and providing assistance in trouble shooting more difficult problems. Quality control charts are included as Attachment #9. As part of the laboratory alert system, quality control data, which are out of acceptable limits, are automatically flagged via the statistical quality control program and action taken in accordance with the control loop (see attachment #10).

On rare occasions when samples are sent to other laboratories, synthetic standards, NIST type certified materials, duplicates, and blanks are sent to monitor the quality of the data returned. In addition, only properly accredited and/or certified laboratories are used.

3. Proficiency Testing

The laboratory participates in many inter-laboratory proficiency testing programs. Proficiency test samples are analyzed in a manner similar to routine samples. The following is a list of current programs:

AIHA Proficiency Analytical Testing Program (PAT)

ELPAT Program for soil, paint and wipes

ERA WP Program

Ambient Source Sampling Audits (by EPA) for lead

The laboratory adheres to the following guidelines regarding proficiency testing:

- Conduct proficiency testing for each analyte or

where proficiency testing is not available, maintain appropriate validating documentation.

- Conduct proficiency testing at the certifying agencies required frequency.
- Utilize an approved proficiency testing service.
- Follow proficiency testing provider's analyzing and reporting instructions.
- Notify certifying agency of a change in provider.
- Maintain a copy of all proficiency testing records.
- Submit corrective action to certifying agency for values outside acceptable limits.

4. Laboratory Reagents and Standards Log and Traceability

All laboratory reagents are to meet or exceed the quality specified by the method. Generally, unless a higher grade is recommended, reagents are ACS grade or better. For all standards the following information will be recorded in the appropriate standards logbook and on the standards bottles:

1) Date of preparation
2) Acid matrix of standards
3) Concentration of standards
4) Initials of the analyst preparing the standard
5) Source of standards

Laboratory reagents are inspected, dated and initialed upon receipt. Reagents are not used beyond theexpiration date (eg. pH buffer solutions) or if the internal QC suggests a problem. Intermediate reagent containers are labeled with the following information:

1) Date of preparation
2) Matrix
3) Concentration
4) Initials of the analyst

Item number 5, Source of Standards, requires some specific guidelines to ensure a consistent, useable method of traceability. All standards are made from high purity metals and confirmed by third party reference materials or previous standards. Purchased standards are NIST traceable. Standards are not used beyond expiration dates or if the internal QC's (eg. ICV's or LCS's) suggest a problem.

Source of Standards for Stock Solutions will be conducted as follows:

A. For Atomic Absorption (AA):

The AA standards logbook will continue to be used. 1000 ppm stocks will continue to be assigned a sequential lot number. At the time of this writing, the next consecutive lot number for stock solutions will be #59. The source of the stock solution will be written in both the standards log book and on the stock solution bottle. Pertinent information will include the chemical compound or element, the manufacturer, the manufacturer's lot number and the weight and final volume of the reagents used. Expiration dates where applicable will be recorded.

B. For ICP

The ICP log book will continue to be used to document the makeup of ICP stock standards and intermediate standards. All of the pertinent information noted for AA standards will also be recorded for ICP standards. The numbering system currently in use for ICP stocks will be maintained. Stocks are identified with a lot number using the month number and the last two digits of the year number (e.g., stocks made up in September of 1989 have the lot #989). There are five different elemental groups of ICP stocks, hence the numbering system 989-1 through 989-5.

Source of Standards for Working Standards:

Working standards will reference the stock solution lot number and the date the serial dilution was made from the stock (e.g., serial dilution of stock lot #59, 6/6/94). This information will be recorded on the standard bottle, and on the analytical run logs in the raw data every time a standard is used.

4. Standard Reference Materials

Serial dilution of standard reference materials will contain all of the same information on the container applicable to standards (i.e., date, matrix, concentration, initials of preparer and source including manufacturer's lot number). In-house lot numbers will not be assigned to standard reference materials. The source and manufacturer's lot number will be recorded in the analytical run data (i.e., Spex 19 lot #504).

5. Standards Disposal

QUALITY CONTROL REQUIREMENTS

QC Analysis	Source	Frequency Requirements	Control Limits	Corrective Action Required
Initial Calibration Verification (ICV) Continuing Calibration Verification (CCV)	Standard Reference Materials In House Standards and/or SRM's	Following Calibration 10%	+or-10%/95%Confidence Interval "	Correct Problem and Recalibrate "
Initial Calibration Blank (ICB) Continuing Calibration Blank (CCB)		Following Calibration 10%	< CRDL "	Recalibrate
Prep Blank	DI Digestion Blanks	1 per Batch, per Method	<CRDL	Correct Problem Redigest and Reanalyze unless samples are 10x blank conc.
Matrix Spike	Aqueous Solutions	1 per Batch, per Method; 10% frequency for 200.7	+or- 30% for200.7 +or- 25% for 6010	Identify Problem and correct and/or flag samples
Duplicate Sample Analysis	Sample from Batch not to be a Field Blank	1 per Batch, per Method	a)RPD of +or- 20 if conc. >5XCRDL b)if conc. <5XCRDL, +or- CRDL c)if conc. <CRDL no criteria	Flag Samples per CLP SOW
Laboratory Control Sample (LCS)	Aqueous SRM for Aqueous Samples Solid SRM for Solid Samples	"	+or-20%/95% Confidence Interval; +or-15% for methods 200.7 and245.1	Correct Problem, Redigest, Reanalyze

**Batch is defined as group of 20 field samples

Standard reference materials will be disposed of when they met the expiration date. Standards will always be validated with a current standard reference material and will be disposed of when they can no longer meet the + or - 10% ICV guidelines set for laboratory quality assurance.

6. Examples

Refer to attachment #11 for an example of the standards log and its analytical documentation.

VIII. DATA REDUCTION, VALIDATION AND REPORTING

All standard curves, quality control information, raw data, and mathematical manipulations of data are recorded in ink in the hard bound laboratory workbook. Any corrections are made with a single strike out line dated and the analyst's initials. Each analyst maintains his or her workbook and files completed workbooks for future reference.

The sample and quality control data is logged into the LIMS data base where final reports are generated. After the reports are generated sample and quality control data are independently reviewed by a second analyst. Below is an outline of the checking procedures used to verify the reportable data. At least 20% of all data entries are checked in this manner. If during the checking process, errors are determined, 100% of the data set will be checked.

The analyst performing the data processing shall give the data package to an analyst independent of the work for checking. The package shall include, as appropriate, raw data, data sheets, strip charts, computer input\output, calculations, sources for input parameters such as response factors, etc.

The independent analyst (reviewer) shall, as applicable, review the data for:

- Appropriateness of equations used
- Correctness of numerical input
- Numerical correctness of calculations
- Correct interpretation of strip charts, etc.

To determine if Q.C. measures satisfy the

requirements in the Laboratory's Quality Assurance Manual (section VII), the reviewer shall insure that the following criteria have been met. Any deficiencies shall be noted and brought to the attention of the originator.

I. Calibration Curve

1. Frequency - Daily or more frequently as appropriate?
2. Standards - Blank and 3 standards?
3. Range - Appropriate?
4. Correlation coefficient - > .995?
5. Initial calibration verification - 90-110%
6. Continuing calibration verification - 90- 110%

II. Laboratory Control Sample

1. Matrix - Appropriate?
2. Frequency - 1 per 20 or 1 per run?
3. % Recovery - 80-120% (method 6010), 85-115% (methods 200.7 and 245.1) or within 95% confidence interval?

III. Prep Blanks

1. Matrix - Acid matched?
2. Frequency - 1 per 20 or 1 per run?
3. Level - > Lowest reportable limit?

IV. Matrix Spikes

1. Frequency - 1 per 20, [1 per 10 (method 200.7)] or 1 per run?
2. Preparation - Pre or post digestion?
3. % Recovery - 75-125% (method 6010), 70-130% (method 200.7)

V. Matrix Duplicate

1. Frequency - 1 per 20 or 1 per run?
2. Preparation - Entire procedure?
3. % RPD - <20%?

VI. Sample Analysis

1. Holding times - Met?

All entries and calculations that the reviewer reviews shall be marked. The checking process must be thorough enough to validate that the results are correct.

- Any changes made by the reviewer shall be back-checked by the originator. If the originator agrees with the change, no action is necessary. If the originator disagrees, the originator and reviewer must resolve the difference so they agree with the result presented.

- The reviewer shall sign the data package. Signing indicates that the reviewer agrees with the calculations and that any changes made have been agreed to by the originator.

This process must be satisfactorily completed for the data to be considered valid.

The laboratory manager shall review testing results prior to external distribution. The laboratory manager shall:

- Compare analyses performed to the proposed testing record.

- Review results for reasonableness and consistency of reporting limits.

- Review quality control data results.

- Verify that required checking was properly performed.

- Review sample preservation and any holding time requirements.

If the review indicates that the data meets project quality requirements, the laboratory manager will approve data package by signature. All analytical information will be kept for an indefinite period in our computer files.

IX. ANALYTICAL REPORTS AND OTHER DELIVERABLES

The following information is included with each analytical report (see attachment #12).

1. A cover letter referencing the project, pertinent sample information and any sample or analytical abnormalities.

2. Batch and sample number.

3. Date collected.

4. Sample description.

5. Parameter.

6. Value and Units of Concentration.

7. Analyst.

8. Date Analyzed.

9. Holding Times.

10. Method of Analyses.

11. Quality Control Data (provided if requested).

Each report is reviewed for accuracy of calculations, transcription errors, etc. by a second analyst and approved by the laboratory manager prior to distribution.

It is the policy of ASARCO Inc. to keep all ASARCO Laboratory records and reports on computer file and in hard copy indefinitely. Records for commercial clients, both hard copy and computer files are kept a minimum of ten years.

X. STANDARD OPERATING PROCEDURE (SOP's)

The utilization of SOP's in both the field and laboratory is considered to be a critical component in maintaining a high level of quality and consistency. All field and laboratory personnel are to have ready access to any of the applicable SOP's. SOP's are to be reviewed and dated by the laboratory coordinator and approved and dated by the laboratory manager on an annual basis. The adoption of new SOP's or revision of existing SOP's are performed by the lab coordinator and lab manager. The following table is a list of specific laboratory functions for which a written SOP is available.

XI. Physical Facility

The physical facility is designed to insure that the laboratory staff has suitable space, utilities and equipment to enable them to conduct their tests in a safe and healthful environment and produce quality data. Separate areas have been designated for sample receipt, storage, chemical storage, waste storage, data handling, and incompatible tests. The facility is inspected on a regular basis for health and safety purposes. Both the facility and records are available for inspection by the certifying agency.

Laboratory SOP's	Location
Sample Preservation	Quality Assurance Program, Section III
Sample Custody	" "
Holding Times	" "
*Sample Receipt	Quality Assurance Program, Section IV
Sample Handling & Distribution	Quality Assurance Program, Section V
Sample Preparation and Analyses	Quality Assurance Program, Section VI
*Standard Traceability & Source	" "
Laboratory QC Samples	Quality Assurance Program, Section VII
Data Assessment	Quality Assurance Program, Section VIII
Data Validation	" "
Data Useability	" "
Data Generation	Quality Assurance Program, Section IX
Sample Storage Sample Disposal Glassware Cleaning Sample Digestion	Posted or Distributed as Necessary

*Also posted or distributed.

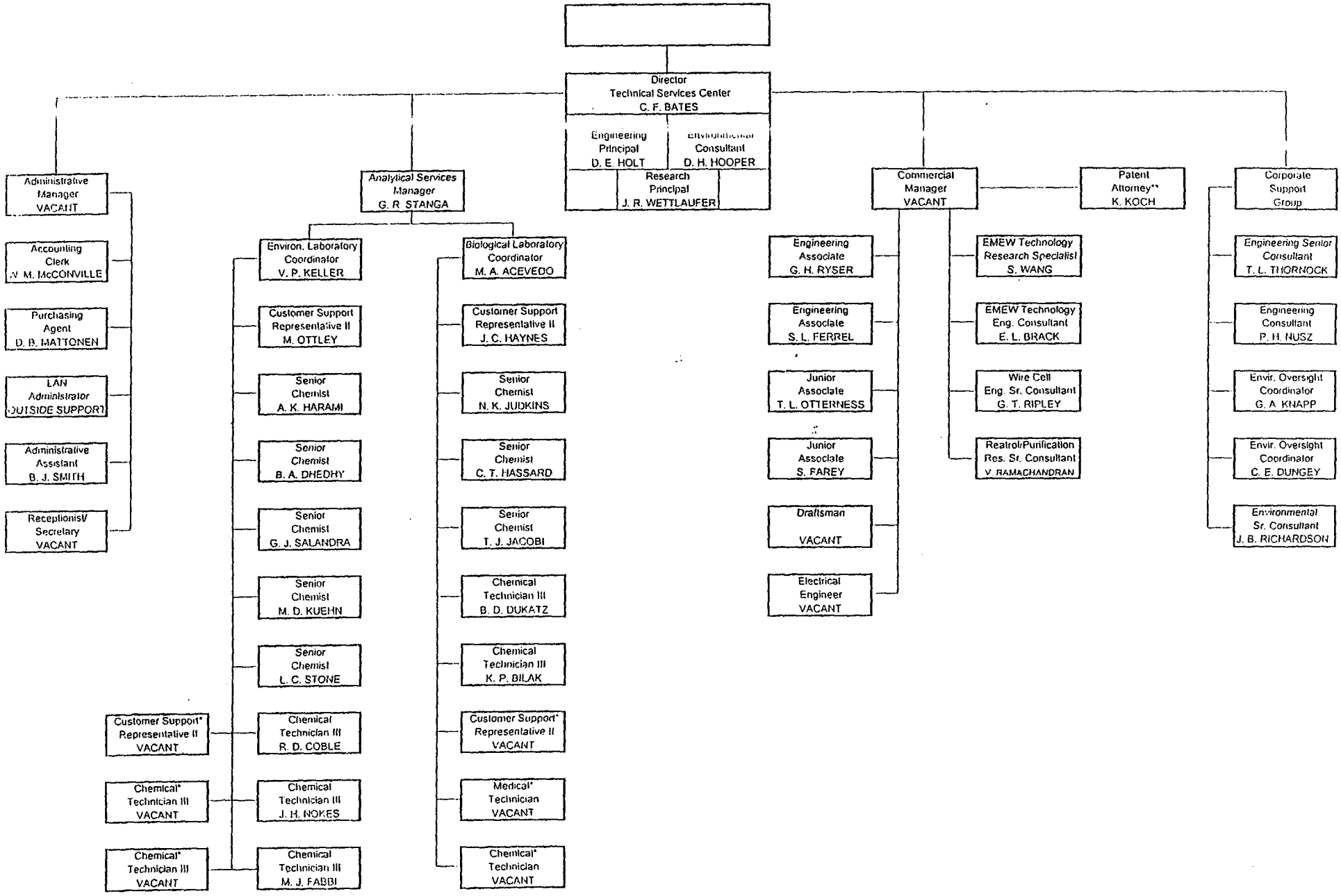
FIELD SOP'S

The following field SOP's are addressed by the sampling contractor and are to be included in the project specific sampling and laboratory QAPP:

- Sample Collection
- Field Log Book
- Sample Packaging
- Field Measurements
- Consumable Procurement
- Documentation
- Sample Shipments

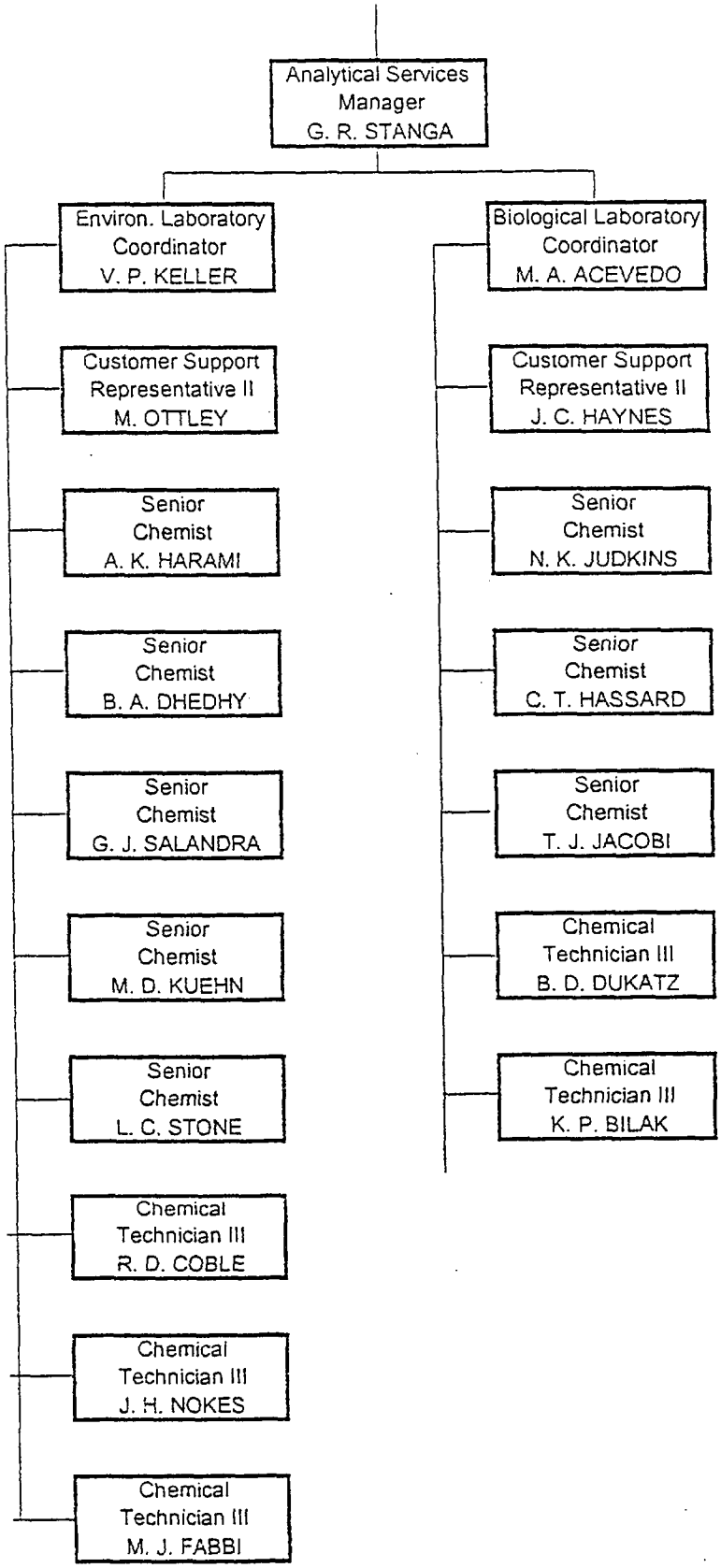
ATTACHMENT 1

ORGANIZATION CHART AND EMPLOYEE RESPONSIBILITY



* Needed to go from 160,000 analyses/yr. to 240,000 analyses/yr.
** To be used as needed.

TECHNICAL SERVICES CENTER
ORGANIZATIONAL CHART
January 11, 2000


Analytical Services Manager
G. R. STANGA
Environ. Laboratory Coordinator
V. P. KELLER
Customer Support Representative II
M. OTTLEY
Senior Chemist
A. K. HARAMI
Senior Chemist
B. A. DHEDHY
Senior Chemist
G. J. SALANDRA
Senior Chemist
M. D. KUEHN
Senior Chemist
L. C. STONE
Chemical Technician III
R. D. COBLE
Chemical Technician III
J. H. NOKES
Chemical Technician III
M. J. FABBI
Biological Laboratory Coordinator
M. A. ACEVEDO
Customer Support Representative II
J. C. HAYNES
Senior Chemist
N. K. JUDKINS
Senior Chemist
C. T. HASSARD
Senior Chemist
T. J. JACOBI
Chemical Technician III
B. D. DUKATZ
Chemical Technician III
K. P. BILAK

CHEMICAL TECHNICIAN JOB FAMILY

POSITION	DESCRIPTION	GRADE
Chemical Technician I	Entry level position. Under direct supervision performs a variety of simple and routine chemical tests and analyses.	8
Chemical Technician II	Under general supervision, performs a variety of chemical tests and analyses. Typically, requires a minimum of 1 year of Chemical Analyst I experience. Performs method development for laboratory processes.	10
Chemical Technician III	Under limited supervision, performs more complex chemical test and analyses on major projects. Is competent to work in most areas of the laboratory. Uses judgment in the independent evaluation, selection and adaptation of standard methods. Performs method development and evaluation for laboratory processes. Participates in the technical training of new employees. Typically, position requires a minimum of 6 years experience.	12

CHEMICAL TECHNICIAN JOB FAMILY (cont.)

POSITION	DESCRIPTION	GRADE
Senior Chemist	This position represents the highest technical skill. Independently performs most assignments with instruction as to the general results expected. Plans and conducts work requiring mastery of specialized analytical techniques. Supervises and performs method development and evaluation for laboratory processes. Trains and supervises less experienced analysts. Position requires a bachelors degree in Chemistry or related allied field with minimum of 8 years of diverse laboratory work.	14
Laboratory Coordinator	Supervises the daily activities of the Senior Chemists and Chemical Technicians. Coordinates and distributes sample workload. Tracks progress of assigned projects to ensure timely completion. Interacts with plant personnel and commercial clients on a wide variety of issues. Participates in planning lab programs on the basis of specialized knowledge. Organizes and implements laboratory programs. Insures implementation of quality assurance program and oversees proficiency testing programs and corrective action plans. Position requires a bachelors degree in Chemistry or allied related field with a minimum of 10 years of diverse analytical laboratory operations.	16

CUSTOMER SERVICE REPRESENTATIVE JOB FAMILY

POSITION	DESCRIPTION	GRADE
Customer Service Representative I	Entry level - Acts as the secondary customer contact for intercompany and commercial accounts regarding pricing, scheduling and shipping inquiries. Ensures that customers receive the best service possible through processing orders and preparing general correspondence. Strong communication skills is required.	8
Customer Service Representative II	Acts as the customer contact for intercompany and commercial accounts regarding pricing, scheduling and shipping inquiries. Ensures that customers receive the best service possible through processing orders, preparing general correspondence, and coordinating with other functions as required. Strong communication skills and knowledge of laboratory environment required.	11
Senior Customer Service Representative	Primary customer contact for intercompany and commercial accounts regarding pricing, scheduling and shipping inquiries. Ensures that customers receive the best service possible through processing orders, preparing general correspondence, and coordinating with other functions as required. Assists management in planning and coordinating the marketing and advertising of the laboratory. Supervises other Customer Service Representatives. Minimum of five years of customer service work experience in Laboratory environment.	13

MEDICAL TECHNOLOGIST JOB FAMILY

POSITION	DESCRIPTION	GRADE
Medical Technologist I	Entry level position. Under direct supervision, performs simple and routine analysis of biological samples with same day turnaround time. Position requires a bachelors degree in Medical Technology or allied related field.	10
Medical Technologist II	Under minimal supervision, performs more complex analysis and tests of biological samples. Has a working knowledge of instrument operation, maintenance and troubleshooting. Maintains internal quality assurance program. Reviews and enters data into the laboratory information system. Participates in method development and laboratory certification procedures. Position requires a bachelors degree in Medical Technology or allied related field with a minimum of 2 years experience in a clinical laboratory including chemistry, hematology and urinalysis.	12
Senior Medical Technologist	Independently performs most assignments with instruction as to the general results expected. Oversees all activities in the clinical section and is responsible for timely reporting and quality of analyses. Selects, modifies and develops methodologies to enhance analytical capabilities. Trains and supervises less experienced employees. Maintains quality assurance programs. Position requires a bachelors degree in Medical Technology or allied related field with a minimum of 5 years experience in a clinical laboratory including chemistry, hematology and urinalysis.	14

ATTACHMENT 2

SUBMITTAL/CHAIN-OF-CUSTODY FORMS

Laboratory Services Request Form
Enviro. .ental

INFORMATION

Requesting Service: _____
on Requesting Service: _____
ct Description: _____
Project No.: _____
ples Collected By: _____

II. REPORT INSTRUCTIONS

Orginal Report To: _____
Additional Copy Of Report To: _____
Services Requested Below
are Requested No Later Than: _____ Date
Please Forward Results by: US Mail ( ) Red BX ( ) Fax ( ) Other ( )

SEND REQUESTS

ASARCO
TSC LABORATO
3422 South 700 W
Salt Lake City, U
84119
Your Customer Ser
Representative is:
Jodie Haynes

Phone no: (801) 263-

YPE OF SERVICE REQUESTED:

lease send the following supplies:
( ) Sampling media or containers Please Specify _____

( ) Laboratory services forms ( ) Other _____

ease analyze the enclosed samples for:

pling & Time	Sample I.D./Description/Tag No.	No. of Containers	Analyses Requested	Comments

OF CUSTODY RECORD

w Below This Point

	Date	Time	Courier Company Name:		Shipping Airbill #	
	Date	Time	Received By:	Date	Time	
	Date	Time				

AEC LABORATORIES

Laboratory Services Request Form

CLIENT INFORMATION

Client Name:

Client Address:

Client Phone:

Client Fax:

ACCOUNT INFORMATION

Account Name:

Account Address:

P.O. No:

SEND REQUESTS TO:

AEC LABORATORIES

3422 South 700 West

Salt Lake City, UT

84119

Your Customer Service Representative is:

Jodie Haynes

Phone # (801) 261-1421

Fax # (801) 264-9833

REPORT INSTRUCTIONS

Report Results To:

Report Address:

Please Forward Results By: US Mail ( ) FedEx ( ) Fax ( ) Other

Services Requested below are required no later than (date)

TYPE OF SERVICE REQUESTED

Please analyze the enclosed Industrial Hygiene samples for:

Use Only	Field Sample No./Description	Date Sampled	Air Vol. (liters)	Time (min.)	ug/ filter	ug/m3	Fibers/ filter	Analyses Requested

Please analyze the enclosed Environmental samples for:

Use Only	Field Sample No./Description	Sampling Date & Time	No. of Cont.s	Analyses Requested

Send the following supplies:

Laboratory Request Forms ( ) Sampling Media (please specify)

Other

COMMENTS

946

	SAMPLERS: (Signature)	SAMPLE SITE
	SAMPLING CO.	

DATE	TIME	SAMPLE I.D. / DESCRIPTION / TAG NO.	NO. OF CONTAINERS	TYPE	ANALYTES	REMARKS

	DATE	TIME	RECEIVED (Signature):	RELINQUISHED (Signature):	DATE	TIME	RECEIVED (Signature):
	DATE	TIME	RECEIVED (Signature):	RELINQUISHED (Signature):	DATE	TIME	RECEIVED (Signature):
	DATE	TIME	RECEIVED (Signature):		DATE	TIME	REMARKS

Industrial Hygiene Samples

PLANT INFORMATION

Plant Requesting Services
Person Requesting Service
Project Description
Your Project No.

SEND REQUE

ASARCO
TSC LABORA
3422 South 7(
Salt Lake Cit
84119
Your Customer Ser
Representative is:
Jodie Haynes
phone no. (801) 26

REPORT INSTRUCTIONS

Original Report To
Additional Copy of Report To:
Services Requested below are required no later than _____ (date)

SAMPLE INFORMATION

Personal Monitor

Employee Name
Employee No.
Employee S.S.N.
Department
Job Classification
Job Code
Respirator Type

Stationary Monitor

Department
Department Code
Area Description

te sampled _____ Shift _____ Pump/rotameter No. _____
mpling Conditions _____
(Temp (F)) (Barometric pressure (in Hg))

TYPE OF SERVICE REQUESTED

Please analyze the enclosed samples for:

Personal Monitor Only Badge No.	Filter Cassette No.	Time On	Ball On	Time Off	Ball Off	Total Minutes Sampled	Analyses Requested	To

ase send the following supplies:
) Laboratory Request Forms ( ) Sampling Media (please specify) _____
) Other _____

COMMENTS (If applicable check appropriate box and explain below)

Sample Collection Abnormality (3)
Ventilation System Malfunction (4)
Unusual Work Duties (5)
Time Weighted Average (6)

[ ] Unusual Weather Conitions (7)
[ ] Process Equipment Malfunction, Shutdown, or Curtailment (8)

ation: _____

servation Or Activit _____

ATTACHMENT 3

LOGIN/CHAIN -OF-CUSTODY FORM

LOGIN CHAIN OF CUSTODY REPORT (ln01)
Dec 18 1998, 09:52 am

Login Number: L982521
Account: 7818 East Helena
Project: 3119 Water and Solid Waste

Laboratory Sample Number		Client Sample Number	Collect Date	Receive Date	PR	Due Date
L982521-1		HDS-E001	14-DEC-98	18-DEC-98		28-DEC-98
HDS Effluent						
Water	S	AS (TR)	Hold:12-JUN-99			1 Bottles
Water	S	CD (TR)	Hold:12-JUN-99			
Water	S	CU (TR)	Hold:12-JUN-99			
Water	S	FE (TR)	Hold:12-JUN-99			
Water	S	HG	Hold:11-JAN-99			
Water	S	PB (TR)	Hold:12-JUN-99			
Water	X	QC DELIVERABLES 10%				
Water	S	SE (TR)				
Water	S	TL (TR)	Hold:12-JUN-99			
Water	S	ZN (TR) Dan 12/15	Hold:12-JUN-99			

Signature:

Date: 12/18/98 $1000 ??

ATTACHMENT 4

CENTRAL LOGBOOK RECORD

ATTACHMENT 5

LOGIN CHECKLIST FORM

LOG-IN CHECKLIST

DATE REC'D: _____

SAMPLE ORIGIN _____

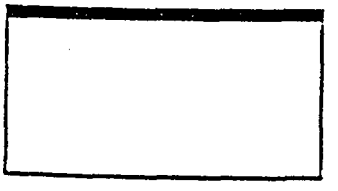
BATCH # _____

SHIPPING CONTAINERS INTACT: Yes_____ No_____

COC SEALS: PRESENT: Yes____ No____

TAMPER PROOF: Yes____ No____ INTACT: Yes____ No____

LOCATION: Left___Right___Front___Back____



SAMPLE CONTAINERS INTACT: Yes_____ No_____

SAMPLE MATRIX

WATER	SOIL	VEGETATION	MISC./SOLID

CORRECT PRESERVATION		Yes	No	N/A
Metals	(HNO_3)			
Un-Preserved TDS, TSS, Alk., Cl-, F-, Cond., SO4=, S.Grav., NO3, NO2, pH Hardness, Flashpoint, Cr+6	(RAW)			
Nutrients	(H_2SO_4)			
CN-	(NaOH)			
Phenol & P	(H_2SO_4)			
Oil&Grease	(H_2SO_4)			
TEMPERATURE	°C			

COMMENTS _____

_____

_____

Signature

ATTACHMENT 6

LAB WORKBOOK RECORD

Poor Quality Source Document

The following document images have been scanned from the best available source copy.

To view the actual hard copy, contact the Superfund Records Center at 303-312-6473

12/4/98 — Sample 982437-1 (TR) digested per SW846-3005
Aliquots 50/50 ml, Dups & Spikes 25/50 ml (SA EECLP#1)
LCS EE1C0-50 25/50 ml & One Acid prep blank (ER)
Sample 982437-1 also digested for mercury
(Hg) analysis. Warm digestion (H2SO4/KMnO4) in
per 245.1. Aliquots of 35 ml/50 ml & 20/50 ml for
Dups & Spike (Blank 2ppb SA). One LCS Tube #953722-4
2 ml (2ppb) 35 ml and one prep blank taken along
12/4/98

TR samples dilution for ICP-MS analysis
12/9/98 — Samples 982463-1 TR digested per SW846-3005
Aliq 50/50 ml, Dups & Spikes 25/50 ml (SA Spex Spk #1)
LCS EE1C0-50 5 ml Spex Tune 5 ml → 50 ml & One
Acid Preparation Blank taken along. 982463-1 (Diss)
concentrated 50/25 ml & Dups 50/25 ml along w samples
Sample 982463-1 also prepared for mercury
analysis warm dig (245.1). Aliquots 35 ml, 20 ml Dups & Spike
(2 ml SA 50 ppb = 2 ppb in Soln). Tube 953722-4 LCS 2 ml (50 ppb) and
one prep. Blank prepared.
12/9/98

12/10/98 — (TR) Samples 982463 dilution for ICP-MS analysis

12/18/98 — Sample 982521-1 TR dig per SW846 3005
Alig 50/50, Dups & Spike 25/50 ml (SA Spex #1) LCS EE1C0-50
& Spex 5/25/50 ml = 50 ppm & One Acid Prep Blank.
Sample 982521-1 also prepared for (Hg) mercury
analysis method 245.1 (warm dig). Aliquots of
35 ml, 20 ml Dups & Spike (SA 2 ppb). Tube 953722-4 LCS
of 2 ppb & one acid prep blank prepared.
12/18/98

-, 1/98 [illegible] in (Zn) [illegible] AA, YE 303 [illegible] SOP

(λ 213.) [illegible] 180° (direct) .02ppm/[illegible] .05ppm/[illegible]

.50ppm/.128 abs 1.0ppm/.231 abs 2.0ppm/.452 abs r² [illegible]

*₂ Sample #	conc	mg/ml	conc (ppm)
[illegible] Blank	—	–.00	
[illegible] Spike QC 21 @ 1.0ppm		.35	
Spray [illegible] 1 x 1/500		.07–.08)	.08 TV
9824-7-1 (TR)	50/50ml	.68	.68 }
"	" (x5 [illegible])	.14–.13	.07
[illegible] " [illegible]	25/50ml	.33	.66 } 3.0% RPD
Spike " (SHEELP[illegible])	"	.56	1.12 – .68 / .50 SA = 88% R
ICS Elt 20-50	.25ml/50ml	.25	.25/.25 TV = 100% [illegible]
[illegible] [illegible] Blank 2/4	50–750ml	≤.01	<.02
[illegible] 1.0ppm Std	—	1.01	—
[illegible] Blank	—	–.01	—

* [illegible] [illegible] [illegible] every other sample

12/8/98 [illegible]

ATTACHMENT 7

METHOD DETECTION LIMITS

Total Metals Method Detection Limits
6010B / 200.7

Element	Method Detection Limit (ppb)	Analysis Date
Ag	0.7	May 19, 1998
Al	18.5	September 22, 1998
As	4.6	September 22, 1998
Ba	5.5	May 19, 1998
Be	0.2	May 19, 1998
Ca [315.887]	21.1	September 22, 1998
Cd	0.4	September 22, 1998
Co	0.5	May 19, 1998
Cr	1.2	May 19, 1998
Cu	8.5	May 19, 1998
Fe	24.9	September 22, 1998
K	1708	September 22, 1998
Mg	5.2	September 22, 1998
Mn	0.3	September 22, 1998
Mo	0.8	May 19, 1998
Na	589	September 22, 1998
Ni	1.7	May 19, 1998
Pb	3.9	September 22, 1998
Sb	6.4	May 19, 1998
Se	8.3	September 22, 1998
Sn	7.3	May 19, 1998
Ti	0.6	September 22, 1998
Tl	9.5	May 19, 1998
V	0.8	September 22, 1998
Zn	16.8	September 22, 1998

TCLP Method Detection Limits

Conducted in accordance with 40 CFR Ch.1, Pt. 136, App. B

Element	Method Detection Limit (ppb)	Analysis Date	Method of Analysis
Ag	1.4	May 19, 1998	6010
As	4.4	May 19, 1998	6010
Ba	1.3	May 19, 1998	6010
Cd	0.7	May 19, 1998	6010
Cr	1.1	May 19, 1998	6010
Pb	7.6	May 19, 1998	6010
Se	9.6	May 19, 1998	6010
Hg	0.031	January 16, 1998	7470

ASARCO LABORATORY METHOD DETECTION LIMITS FOR
PE SCIEX ELAN 6000 ICP-MS
EPA Method 6020 CLP-M /200.8

	MASS	MDL (ppb)	Date MDL Completed
Ag	107	.046	9/10/98
Ag	109	.054	9/10/98
Al	27	8.9	9/10/98
As ArCl correction / Se 78	75	.300	9/10/98
As ArCl correction / Se 82	75	.188	9/10/98
Ba	135	.022	8/7/98
Ba	137	.031	8/7/98
Be	9	.022	9/10/98
Cd	111	.031	9/10/98
Cd MoO correction	114	.015	9/10/98
Cd	114	.015	9/10/98
Co	59	.022	9/10/98
Cr	52	.089	8/7/98
Cu	63	.078	8/7/98
Cu	65	.046	8/7/98
Mn	55	.035	8/7/98
Mp	97	.057	9/10/98
Mo	98	.044	9/10/98
Ni	60	.368	8/7/98
Ni CaO correction	60	.368	8/7/98
Pb	208	.186	9/10/98
Sb	121	.047	8/7/98
Sb	123	.017	8/7/98
Se	78	.959	9/10/98
Se	82	.102	8/7/98
Ti	49	.057	8/7/98
Tl	205	.234	9/10/98
V	51	.47	8/7/98
Zn	66	.983	8/7/98
Zn	68	.953	8/7/98

ASARCO Environmental Laboratory

METHOD DETECTION LIMITS

Parameter	EPA Method #	Date Conducted	MDL (ppm)
CN-	335.2	4/21/97	.001
Cl-	325.2	5/28/97	.77
NO2/NO3	353.2	6/9/97	.018
PO4	365.1	6/2/97	.005
Phenol	420.1	4/10/97	.006
NH3/N	350.1	5/16/97	.020
SO4	9036	5/29/97	.73
TKN	351.2	8/1/97	.042
TP	365.4	7/31/97	.023
TDS	160.1	12/12/97	7.95
TSS	160.2	12/15/97	.61
Hg	245.1	1/16/98	.00003
Alkalinity	310.1	6/23/98	.44

ATTACHMENT 8

INSTRUMENT MAINTENANCE AGREEMENTS

PERKIN ELMER

QUOTATION

The Perkin-Elmer Corporation
761 Main Avenue
Norwalk, CT 06859-0001
Phone: (800) 762-8288 Fax: (203) 762-4300
www.perkin-elmer.com

MR GARY STANGA
ASARCO INC
3422 SOUTH 700 WEST
TO SALT LAKE CITY UT 84119

Quotation No: Q062701
Original Quotation Date: 10/03/1998
Quotation Validity Date: 09/24/1998 to 12/23/1998
Contract Coverage: 01/01/1999 to 12/31/1999
Contract Description: STANDARD PROTECTION

TELEPHONE: 801 263 5251
FAX: 801 264 9838
YOUR REFERENCE:

Prior Customer P.O. No.:

This Agreement is entered into between PERKIN ELMER and the undersigned Customer in consideration of the payments provided for in this Agreement. Subject to the terms and conditions of this Agreement, PERKIN ELMER agrees to perform the services set forth in the coverage of this Agreement on the equipment listed below for the period described.

ITEM NO	QTY	ITEM DESCRIPTION/ COVERAGE DATES	(SERIAL NUMBER)	COVERAGE	GROSS PRICE/MTH	NET PRICE/MTH
010	1	AS60 FURNACE AUTOSAMPLER Begin Date: 01/01/1999 End Date: 12/31/1999	(6936)	P,L,T with OPM	$ 84.00	$ 71.40
020	1	AS60 FURNACE AUTOSAMPLER Begin Date: 01/01/1999 End Date: 12/31/1999	(8424)	P,L,T with OPM	$ 84.00	$ 71.40
030	1	EDLSY ITEM2 VOLTAGE MODULE Begin Date: 01/01/1999 End Date: 12/31/1999	(42078)	P,L,T with OPM	$ 38.00	$ 32.30
040	1	HGA6(0 FURNACE POWER SUPPLY Begin Date: 01/01/1999 End Date: 12/31/1999	(4599)	P,L,T with OPM	$ 98.00	$ 83.30
050	1	HGA6: 0 FURNACE POWER SUPPLY Begin Date: 01/01/1999 End Date: 12/31/1999	(5526)	P,L,T with OPM	$ 98.00	$ 83.30
060	1	ZEEM/ N5100 BGC ACCY ** Begin Date: 01/01/1999 End Date: 12/31/1999	(6235A1)	P,L,T with OPM	$ 103.00	$ 87.55
070	1	ZEEM N5100 BGC ACCY ** Begin Date: 01/01/1999 End Date: 12/31/1999	(7056)	P,L,T with OPM	$ 103.00	$ 87.55

This quotation is subject to the terms and conditions attached.
NOTE: Customer is responsible for applicable taxes, including sales, use and/or excise tax.
PLEASE SIGN THIS MAINTENANCE AGREEMENT QUOTATION AND RETURN ORIGINAL COPY ALONG WITH YOUR PURCHASE ORDER.

PERKIN ELMER

QUOTATION

The Perkin-Elmer Corporation
761 Main Avenue
Norwalk, CT 0585[illegible]-0001
Phone: (800) 762-[illegible]288, Fax: (203) 762-4300
www.perkin-elmer.com

Quotation No: Q062701
Quotation Date: 10/03/1998
Quotation Validity Date: 09/24/1998 to 12/23/1998

ITEM NO	QTY	ITEM DESCRIPTION/ COVERAGE DATES	(SERIAL NUMBER)	COVERAGE	GROSS PRICE/MTH	NET PRICE/MTH
080	1	510[illegible]PC AA INSTRUMENT ** Beg[illegible] Date: 01/01/1999 End Date: 12/31/1999	(131163)	P,L,T with OPM	$ 272.00	$ 231.20
090	1	510[illegible]PC AA INSTRUMENT ** Beg[illegible] Date: 01/01/1999 End Date: 12/31/1999	(145636)	P,L,T with OPM	$ 272.00	$ 231.20
100	1	703 AA INSTRUMENT Beg[illegible] Date: 01/01/1999 End Date: 12/31/1999	(117194)	P,L,T with OPM	$ 223.00	$ 189.55
120	1	OPT[illegible]MA3000DV ICP INSTRUMENT ** Beg[illegible] Date: 01/01/1999 End Date: 12/31/1999	(069N7062302)	P,L,T with OPM	$ 868.00	$ 737.80
121	1	ICP[illegible]OFTWARE ICP SOFTWARE Beg[illegible] Date: 01/01/1999 End Date: 12/31/1999	(069N7062302)	P,L,T with OPM	$ 40.00	$ 34.00
130	1	ASS[illegible]1 FLAME AUTOSAMPLER** Beg[illegible] Date: 01/01/1999 End Date: 12/31/1999	(3610)	P,L,T with OPM	$ 84.00	$ 71.40
140	1	NES[illegible]LABCHILLER COOLING SYSTEM Beg[illegible] Date: 01/01/1999 End Date: 12/31/1999	(197127091)	P,L,T with OPM	$ 44.00	$ 37.40
150	1	PER[illegible]STALTICPUMP PUMP ASSEMBLY Beg[illegible] Date: 01/01/1999 End Date: 12/31/1999	(7053007)	P,L,T with OPM	$ 19.00	$ 16.15
				Total net price:		$ 2,065.50

Net [illegible]rice includes a volume discount of 15.00% (on items eligible for volume discounts only) plus other disc[illegible]nts that may apply less applicable taxes.

NOT[illegible]: Item descriptions above marked with (*) see NOTE 1. Item descriptions above marked with (**) see NOT[illegible] 2.

Note 1: This equipment has not been tested to determine Year 2000 compliance or is not Year 2000 com[illegible]liant. Problems due to Year 2000 non-compliance are excluded from this agreement. Please see the "Exc[illegible]usions" section in the terms and conditions. To learn about new products that are Year 2000 compliant call [illegible]s at 800-762-4000 or e-mail us at info @Perkin-Elmer.com.

PERKIN ELMER

QUOTATION

The Perkin-Elmer Corporation
761 Main Avenue
Norwalk, CT 06859-0001
Phone: (800) 762-8288. Fax: (203) 762-4300
www.perkin-elmer.com

Quotation No: Q062701
Quotation Date: 10/03/1998
Quotation Validity Date: 09/24/1998 to 12/23/1998

ITEM NO	QTY	ITEM DESCRIPTION/ COVERAGE DATES	(SERIAL NUMBER)	COVERAGE	GROSS PRICE/MTH	NET PRICE/MTH

Note 2: Please determine Year 2000 compliance using the attached documentation. If the equipment is not Year 2000 compliant, problems due to Year 2000 non-compliance are excluded from this agreement. Please see the "Exclusions" section in the terms and conditions and contact us at 800-762-4000 or e-mail us at info @Perkin-Elmer.com if you require more information. (www.perkin-elmer.com) and refer to the Terms and Conditions

Zone: Zone 1
Region: INORG RM REGION
Location: USUT01

Contract Notes:

1/98 MERGING OPTIMA3000DV/PUMP/CHILLER/AS91 FOR 12 MONTHS.
12/21 DELETED (1) 703 PER BRIAN.

PERKIN ELMER

QUOTATION

e Perkin-Elmer Corporation
31 Main Avenue
Norwalk, CT 06859-0001
Phone: (800) 762-6288, Fax: (203) 762-4300
www.perkin-elmer.com

Quotation No: Q062701
Quotation Date: 10/03/1998
Quotation Validity Date: 09/24/1998 to 12/23/1998

ITEM NO	QTY	ITEM DESCRIPTION/ COVERAGE DATES	(SERIAL NUMBER)	COVERAGE	GROSS PRICE/MTH	NET PRICE/MTH

Monthly Billing Plan

Planned Invoice Date	Monthly Amount
01/01/1999	$ 2,065.50
02/01/1999	$ 2,065.50
03/01/1999	$ 2,065.50
04/01/1999	$ 2,065.50
05/01/1999	$ 2,065.50
06/01/1999	$ 2,065.50
07/01/1999	$ 2,065.50
08/01/1999	$ 2,065.50
09/01/1999	$ 2,065.50
10/01/1999	$ 2,065.50
11/01/1999	$ 2,065.50
12/01/1999	$ 2,065.50

Monthly Billing Plan Total: $24,786.00

Pre-Payment Discount: 5.000 %

Pre-Payment Plan Total: $23,546.40

Bill to/Payer:

ASARCO INC
3422 SOUTH 700 WEST
SALT LAKE CITY UT 84119

Quoted By: Vicki F. Cook

Telephone No: 203-762-6169

Note: Taxes will be applied to your invoice.
We do not have a copy of your tax exemption certificate on file.

Accepted By:

Signature of authorized person

Gary Stanga Manager 1/4/99
Please print name and title Date

B099-009
Customer P.O. Number

Payment Schedule: (Please select one only)

Monthly Billing Plan [ ]

Pre-Payment Plan [X]

Legend

1PM Only (no P.L.T) = One Preventive Maintenance Visit only
2PM Only (no P.L.T) = Two Preventive Maintenance Visits Only
3PM Only (no P.L.T) = Three Preventive Maintenance Visits Only
4PM Only (no P.L.T) = Four Preventive Maintenance Visits Only
6PM Only (no P.L.T) = Six Preventive Maintenance Visits Only

P.L.T with 0PM = Emergency service incl. normal Parts, Labor & Travel w/ No PM's
P.L.T with 1PM = Emergency service incl. normal Parts, Labor & Travel w/ One PM
P.L.T with 2PM = Emergency service incl. normal Parts, Labor & Travel w/ Two PM's
P.L.T with 3PM = Emergency service incl. normal Parts, Labor & Travel w/ Three PM's
P.L.T with 5PM = Emergency service incl. normal Parts, Labor & Travel w/ Five PM's
P.L.T with 6PM = Emergency service incl. normal Parts, Labor & Travel w/ Six PM's

PERKIN ELMER

QUOTATION

The Perkin-Elmer Corporation
761 Main Avenue
Norwalk, CT 06859-0001
Phone: (800) 762-8267 Fax: (203) 762-4300
www.perkin-elmer.com

TO
MR GARY STENGA
BIOTRACE LABS
3440 SOUTH 700 WEST
SALT LAKE CITY UT 84119

Quotation No: Q063363
Original Quotation Date: 10/04/1998
Quotation Validity Date: 11/30/1998 to 02/28/1999
Contract Coverage: 01/01/1999 to 12/31/1999
Contract Description: STD PROT-ELAN 1 PM

TELEPHONE: 801 263 5251
FAX: 801 264 9838
YOUR REFERENCE:

Prior Customer P.O. No.:

This Agreement is entered into between PERKIN ELMER and the undersigned Customer in consideration of the payments provided for in this Agreement. Subject to the terms and conditions of this Agreement, PERKIN ELMER agrees to perform the services set forth in the coverage of this Agreement on the equipment listed below for the period described.

ITEM NO	QTY	ITEM DESCRIPTION/ COVERAGE DATES	(SERIAL NUMBER)	COVERAGE	GROSS PRICE/MTH	NET PRICE/MTH
020	1	AS60 FURNACE AUTOSAMPLER Begin Date: 01/01/1999 End Date: 12/31/1999	(8428)	P,L,T with OPM	$ 84.00	$ 71.40
030	1	AS60 FURNACE AUTOSAMPLER Begin Date: 01/01/1999 End Date: 12/31/1999	(8630)	P,L,T with OPM	$ 84.00	$ 71.40
050	1	AS91 FLAME AUTOSAMPLER** Begin Date: 01/01/1999 End Date: 12/31/1999	(3283)	P,L,T with 1PM	$ 84.00	$ 71.40
070	1	EDLSY ITEM2 VOLTAGE MODULE Begin Date: 01/01/1999 End Date: 12/31/1999	(420295)	P,L,T with OPM	$ 38.00	$ 32.30
080	1	ELAN6000 MAS INSTRUMENT ** Begin Date: 01/01/1999 End Date: 12/31/1999	(91950860)	P,L,T with 1PM	$ 1,544.00	$ 1,312.40
110	1	HGA6[illegible]0 FURNACE POWER SUPPLY Begin Date: 01/01/1999 End Date: 12/31/1999	(5602)	P,L,T with OPM	$ 98.00	$ 83.30
120	1	HGA6[illegible]0 FURNACE POWER SUPPLY Begin Date: 01/01/1999 End Date: 12/31/1999	(5622)	P,L,T with OPM	$ 98.00	$ 83.30

This quotation is subject to the terms and conditions attached.
NOTE: Customer is responsible for applicable taxes, including sales, use and/or excise tax.
PLEASE SIGN THIS MAINTENANCE AGREEMENT QUOTATION AND RETURN ORIGINAL COPY ALONG WITH YOUR PURCHASE ORDER.

PERKIN ELMER

The Perkin-Elmer Corporation
761 Main Avenue
Norwalk, CT 06859-0001
Phone: (800) 762-8888 Fax: (203) 762-4300
www.perkin-elmer.com

QUOTATION

Quotation No: Q063363
Quotation Date: 10/04/1998
Quotation Validity Date: 11/30/1998 to 02/28/1999

ITEM NO	QTY	ITEM DESCRIPTION/ COVERAGE DATES	(SERIAL NUMBER)	COVERAGE	GROSS PRICE/MTH	NET PRICE/MTH
130	1	NESLAB CHILLER COOLING SYSTEM Begin Date: 01/01/1999 End Date: 12/31/1999	(695145140)	P,L,T with OPM	$ 44.00	$ 37.40
150	1	ZEEMAN 5100 BGC ACCY ** Begin Date: 01/01/1999 End Date: 12/31/1999	(7067)	P,L,T with OPM	$ 103.00	$ 87.55
160	1	ZEEMAN 5100 BGC ACCY ** Begin Date: 01/01/1999 End Date: 12/31/1999	(7068)	P,L,T with OPM	$ 103.00	$ 87.55
170	1	3110 AA INSTRUMENT ** Begin Date: 01/01/1999 End Date: 12/31/1999	(311N3042304)	P,L,T with OPM	$ 140.00	$ 119.00
180	1	5000 AA INSTRUMENT Begin Date: 01/01/1999 End Date: 12/31/1999	(119979)	P,L,T with OPM	$ 333.00	$ 283.05
190	1	5100 AA INSTRUMENT ** Begin Date: 01/01/1999 End Date: 12/31/1999	(145322)	P,L,T with OPM	$ 272.00	$ 231.20
200	1	5100P AA INSTRUMENT ** Begin Date: 01/01/1999 End Date: 12/31/1999	(149621)	P,L,T with OPM	$ 272.00	$ 231.20
				Total net price:		$ 2,802.45

Net Price includes a volume discount of 15.00% (on items eligible for volume discounts only) plus other discounts that may apply less applicable taxes.

NOTE: Item descriptions above marked with (*) see NOTE 1. Item descriptions above marked with (**) see NOTE 2.

Note 1 This equipment has not been tested to determine Year 2000 compliance or is not Year 2000 compliant. Problems due to Year 2000 non-compliance are excluded from this agreement. Please see the "Exclusions" section in the terms and conditions. To learn about new products that are Year 2000 compliant call us at 800-762-4000 or e-mail us at info @Perkin-Elmer.com.

Note 2 Please determine Year 2000 compliance using the attached documentation. If the equipment is not Year 2000 compliant, problems due to Year 2000 non-compliance are excluded from this agreement. Please see the "Exclusions" section in the terms and conditions and contact us at 800-762-4000 or e-mail us at info @ Perkin-Elmer.com if you require more information. (www.perkin-elmer.com) and refer to the Terms and Conditions.

PERKIN ELMER

QUOTATION

The Perkin-Elmer Corporation
761 Main Avenue
Norwalk, CT 06859-0[illegible]01
Phone: (800) 762-828[illegible] Fax: (203) 762-4300
www.perkin-elmer.com

Quotation No: Q063363
Quotation Date: 10/04/1998
Quotation Validity Date: 11/30/1998 to 02/28/1999

ITEM NO	QTY	ITEM DESCRIPTION/ COVERAGE DATES	(SERIAL NUMBER)	COVERAGE	GROSS PRICE/MTH	NET PRICE/MTH
		Zone: Zone 1 Region: INORG RM REGION Location: USUT01				

Contract Notes:

12/2[illegible] DELETED 6 ITEMS PER BRIAN: AS40,AS90,DEC,FIAS200,HGA500,ZEEMAN5000

PERKIN ELMER

QUOTATION

The Perkin-Elmer Corporation
761 Main Avenue
Norwalk, CT 06859-0001
Phone: (800) 762-8228 Fax: (203) 762-4300
www.perkin-elmer.com

Quotation No: Q063363
Quotation Date: 10/04/1998
Quotation Validity Date: 11/30/1998 to 02/28/1999

ITEM NO	QTY	ITEM DESCRIPTION/ COVERAGE DATES	(SERIAL NUMBER)	COVERAGE	GROSS PRICE/MTH	NET PRICE/MTH

Monthly Billing Plan

Planned Invoice Date	Monthly Amount
01/01/1999	$ 2,802.45
02/01/1999	$ 2,802.45
03/01/1999	$ 2,802.45
04/01/1999	$ 2,802.45
05/01/1999	$ 2,802.46
06/01/1999	$ 2,802.45
07/01/1999	$ 2,802.45
08/01/1999	$ 2,802.45
09/01/1999	$ 2,802.45
10/01/1999	$ 2,802.45
11/01/1999	$ 2,802.46
12/01/1999	$ 2,802.46

Monthly Billing Plan Total: $33,629.40

Pre-Payment Discount: 5.000 %

Pre-Payment Plan Total: $31,947.72

Bill to/Payer:

BIOTRACE LABS
3440 SOUTH 700 WEST
SALT LAKE CITY UT 84119

Quoted By: Vicki F. Cook

Telephone No: 203-762-6169

Note: Taxes will be applied to your invoice.
We do not have a copy of your tax exemption certificate on file.

Accepted By:

Signature of authorized person

Gary Stanga Manager 1/4/99
Please print name and title Date

B099-008
Customer P.O. Number

Payment Schedule: (Please select one only)

Monthly Billing Plan [ ]

Pre-Payment Plan [X]

Legend

PM Only (no P.L.T) = One Preventive Maintenance Visit only
2PM Only (no P.L.T) = Two Preventive Maintenance Visits Only
3PM Only (no P.L.T) = Three Preventive Maintenance Visits Only
4PM Only (no P.L.T) = Four Preventive Maintenance Visits Only
6PM Only (no P.L.T) = Six Preventive Maintenance Visits Only

P.L.T with 0PM = Emergency service incl. normal Parts, Labor & Travel w/ No PM's
P.L.T with 1PM = Emergency service incl. normal Parts, Labor & Travel w/ One PM
P.L.T with 2PM = Emergency service incl. normal Parts, Labor & Travel w/ Two PM's
P.L.T with 3PM = Emergency service incl. normal Parts, Labor & Travel w/ Three PM's
P.L.T with 5PM = Emergency service incl. normal Parts, Labor & Travel w/ Five PM's
P.L.T with 6PM = Emergency service incl. normal Parts, Labor & Travel w/ Six PM's

spectrace
A Thermo Instruments Company

Service Contract Quotation

Quotation For	Status	Type	Contract Type
	RENEWAL	FULL SERVICE	

Quote Valid Until:
RENEWAL OFFER EXPIRES: 4/01/99

Dates of Coverage for Service Contract
Period Covered By Agreement
1/01/99 To 12/31/99

Ship To Address

ASARCO INC.
TECHNICAL SERVICE CENTER
3422 SOUTH 700 WEST
SALT LAKE CITY UT 84119

8012622459

Bill To Address

ASARCO INC.
TECHNICAL SERVICE CENTER
3422 SOUTH 700 WEST
SALT LAKE CITY UT 84119

8012622459

GARY STANGA

PAGE 1 OF 1	Quote Reference Number Agreement #: 90000219 7	Total Amount 8411.00

Coverage Includes all items listed below

EQUIPMENT / SERIAL NUMBER	INSTALLED / MODEL NUMBER	AMOUNT
6000 SYSTEM 26995-001	6/04/91 6000/50	6710.00
BD., DATA MEMORY (AT CLONE)	AT CLONE	0.00
PUMP, VACUUM ONLY		0.00
TUL 0KV .35MA RH XRAY (4K,5K,6K		1701.00
DETECTOR, ECD AL		0.00

Coverage Excludes:

Computer Systems
X-ray tubes

Except where noted

erms are NET 30

ne PM Visit is included with each FULL ERVICE Agreement. PM visits must be scheduled ior to contract expiration

Quotation totals:

SUBTOTAL	8411.00
TAX	0.00
TOTAL	8411.00

Acceptance of Agreement:

Sign Gary Stanga

Title Lab Manager

Date 12/10/98

PO#:

ACKLNOWLEGEMENT OF RECEIPT OF PO# FOR CONTRACT RENEWALL

spectrace
INSTRUMENTS
A Thermo nstrument Controls, Inc. company

FULL SERVICE
CONTRACT AGREEMENT

I. GENERAL INFORMATION

A Spectrace Instruments service agreement satisfies an ever increasing need for prompt efficient service after the standard warranty for the system has expired.

A FULL SERVICE AGREEMENT covers the following items:

A. All parts costs;
B. All freight costs;
C. All labor costs for travel time and on-site time;
D. All incurred costs such as round trip air fare, rental car, lodging, meals, parking, baggage handling, personal car use, etc.;
E. Preventive Maintenance.

A service agreement allows the customer to accurately determine future repair costs for budgetary purposes, and know that service problems will be handled on a priority basis.

II. EQUIPMENT COVERED

The equipment covered under this Agreement is limited to the system components itemized on the service contract proposal.

III. REPAIR METHODS

If it is determined, after discussion of a problem with a Spectrace Instruments Service Engineer, that the problem is most likely confined to a particular board or module, the Service Engineer may send a replacement/loaner board or module to the customer to install in the system to correct the problem. If this initial attempt does not cure the problem, on-site service will be promptly accomplished. Equipment covered under this Agreement will normally be repaired at the customers site within two (2) working days after determining an on-site visit is required by Spectrace Instruments.

In certain situations it may be necessary to return system components to the Spectrace Instruments factory for repair if on-site service is not practical. In these isolated instances, all shipping costs will be paid by Spectrace Instruments. The customer must contact Spectrace Instruments Service Department for a Return Authorization number and method of shipment when the system must be returned. Spectrace Instruments will make a reasonable attempt to provide loaner equipment in these instances.

Spectrace Instruments, 1275 Hammerwood Ave., Sunnyvale, CA 94089 , 408-744-1414, FAX

IV. RESPONSIBILITY AND EXCLUSIONS

SPECTRACE INSTRUMENTS EXCLUDES OR RESERVES THE RIGHT TO DETERMINE THE FOLLOWING AREAS OF RESPONSIBILITY.

This service Agreement does not cover, and Spectrace Instruments is not responsible for the following:

A. Repair of instrument damage, replacement of parts or increase in service time caused by-

1. failure to continually maintain a suitable environment as prescribed by Spectrace;
2. accident, disaster, transportation, vandalism, neglect, misuse or abuse;
3. another product or device not under Spectrace warranty or a Spectrace agreement ;
4. service of the instrument by other than Spectrace;
5. a non-Spectrace modification;
6. power line failures, fluctuations and/or transients;
7. failure to maintain the SiLi detector at operating temperature, either by loss of liquid nitrogen, or loss of A/C for ECD systems;
8. failure to maintain power or restore power to the ion pump in an ECD system;
9. failure to operate the instrument as prescribed by operating and technical documentation;

B. Any costs, service or repairs required due to damage or breakage of the detector window;
C. Any X-ray tube costs, service , or repairs due to either damage to its window or decreased emission resulting from normal use;
D. Service and parts for cathode ray tube repair when due to loss of display intensity, age, or tube breakage;
E. Service or repairs required because of rearrangement or relocation. Spectrace Instruments service personnel will provide telephone assistance at no charge when help is needed concerning cabling of the system, special requirements of problems, etc.;
F. Delays caused by suppliers in providing materials or service, strikes, delays in transportation, interruption in business by either party or other causes beyond the control of Spectrace Instruments;
G. Any costs incurred by Spectrace Instruments to determine liability;
H. Losses incurred by the customer due to instrument downtime;
I. Consumable items -- paper for printers and plotters, ink ribbons, cassettes, diskettes, window material, etc.;
J. Painting or refinishing instruments or furnishing material thereof;
K. Electrical work done external to the instrument;
L. Installation, maintenance, or removal of alterations or attachments to an instrument or any service which is impractical for Spectrace to render because of such alterations or attachments;
M. Loss of files, data, or programs contained in storage media covered by this Agreement.

Service, repair, parts and freight charges associated with Section IV items A-M will be Billable at Spectrace Instruments service rates in effect at that time.

Spectrace Instruments, 1275 Hammerwood Ave., Sunnyvale, CA 94089 , 408-744-1414. FAX 408-744-1313

V. CUSTOMER ASSISTANCE

A reasonable effort on the part of the customer is expected when problems are encountered. This includes over the phone discussion of the problem, assistance in performing diagnostics' programs, replacement of boards/modules that have been shipped to the customer, simple voltage measurements of the DC power supplies, etc. all of which will be done under the guidance of a qualified service engineer. The customer has the right to refuse to help at the time but runs the risk of delaying repair time beyond normal and reasonable time.

Highly technical support or major assistance will not be expected or requested of the customer.

VI. SERVICE HOURS

Contact with our Service Department will be available between the hours of 8:00 AM and 5:00 PM, Monday through Friday, excluding Spectrace Instruments holidays.

VII. PREVENTIVE MAINTENANCE/ EMERGENCY SERVICE

Spectrace will provide at the customers site one (1) scheduled Preventive Maintenance (PM) visit during the coverage period, and an unlimited number of emergency visits, excluding visits as described in section IV. The visits will include all labor, parts and materials Spectrace deems necessary to maintain the equipment in good operating condition(except those parts specifically excluded from this contract).

VIII. RENEWAL

This Agreement may be renewed for additional successive yearly periods by mutual consent at the rates currently in effect at time of renewal.

IX. PAYMENT TERMS

Standard terms are Net 30 days after date of invoice.

X. MULTIPLE SYSTEM DISCOUNT

Multiple system discounts are available when all systems are at the same location and covered under the same service agreement by the same purchase order number.

XI. MISCELLANEOUS

The customer signed acceptance and purchase order will constitute an offer in accordance with the terms hereof and such offer, upon endorsement of our acceptance by way of return invoice will constitute the contractual agreement.

Unless otherwise stated in writing, Spectrace Instruments' quoted prices do not include sales, use, excise or similar taxes. Consequently, the amount of any present or future tax shall be paid by the customer, or in lieu thereof, customer shall provide Spectrace Instruments with a tax exemption certificate.

Spectrace Instruments, 1275 Hammerwood Ave., Sunnyvale, CA 94089 , 408-744-1414, FAX

Spectrace does not assure uninterrupted or error-free operation of the instrument/s. Spectrace is not responsible for failure to fulfill its obligations under this Agreement due to causes beyond its control.

XII. TERMS AND CONDITIONS

Any terms and/or conditions of the customer's order that are inconsistent with the terms and/or conditions of our Agreement shall not be binding on Spectrace Instruments and shall not be considered applicable to any sales made pursuant to this quotation. No waiver, alteration or modification of any of the provisions of this Agreement shall be binding unless in writing and signed by the Spectrace Instruments Service Manager.

You and Spectrace agree that the complete and exclusive statement of the agreement relating to the subject shall consist of the Agreement and its applicable Amendments and Supplements, including those effective in the future. This statement of the agreements supersedes all proposals or other agreements, oral or written, and all other communications between the parties relating to this subject. This Agreement may not be reassigned without the consent of Spectrace Instruments.

Neither party may bring an action, regardless of form, arising out of this Agreement more than 1 year after the cause of action has arisen. Spectrace may not bring an action for nonpayment more than two years after the date the last payment was due.

XIII. CUSTOMER RESPONSIBILITIES

Customer agrees to provide a suitable environment for the instrument as specified by Spectrace. Customer agrees to operate the instrument in accordance with Spectrace operating procedures and safety precautions. Customer will provide Spectrace full, free, and safe access to the instrument in the event a service call is necessary. Customer agrees to inform Spectrace of changes in location of the instrument prior to movement of the instrument.

Customer agrees to backup, remove, protect, and restore, as applicable, programs, files, data, and removable storage media contained in failing computers covered under this Agreement.

Customer agrees to remove all features, parts, options, alterations and attachments that are not subject to this Agreement before presenting a failed component for exchange or repair.

Parts sent to the customer for exchange are to be returned to Spectrace Instruments within 10 working days after the repair of the instrument. Spectrace Instruments will pay for the return shipping charges. Parts are to be returned via Federal Express Economy unless otherwise directed by a Spectrace Instruments representative. Failure to return the parts within the specified period may be cause for cancellation of this Agreement. The replacement cost of any part lost due to the customers negligence will be paid by the customer.

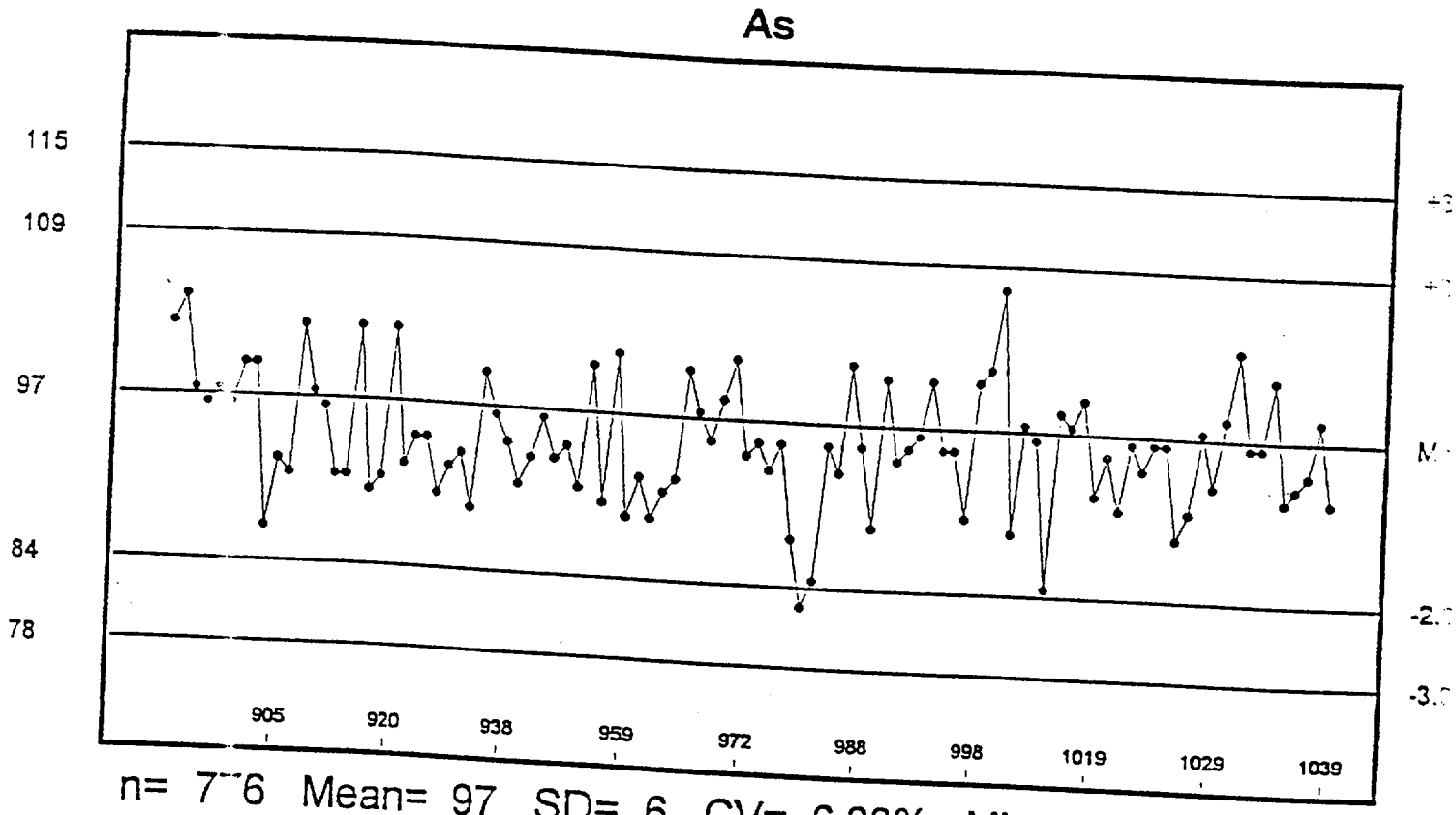
XIV. CANCELLATION

At any time without reason either Spectrace Instruments or the customer may cancel this Agreement. Written notification of cancellation is required. Spectrace Instruments will refund the unused prorated portion of the Agreement rounded to the end of the month cancellation takes place. This Agreement will be null and void at the end of the month cancellation takes place. Allow sixty (60) days for refund. Any refunded portion may be withheld to pay outstanding debt to Spectrace.

Spectrace Instruments, 1275 Hammerwood Ave., Sunnyvale, CA 94089 , 408-744-1414. FAX 408-744-1313

ATTACHMENT 9

QUALITY CONTROL CHARTS



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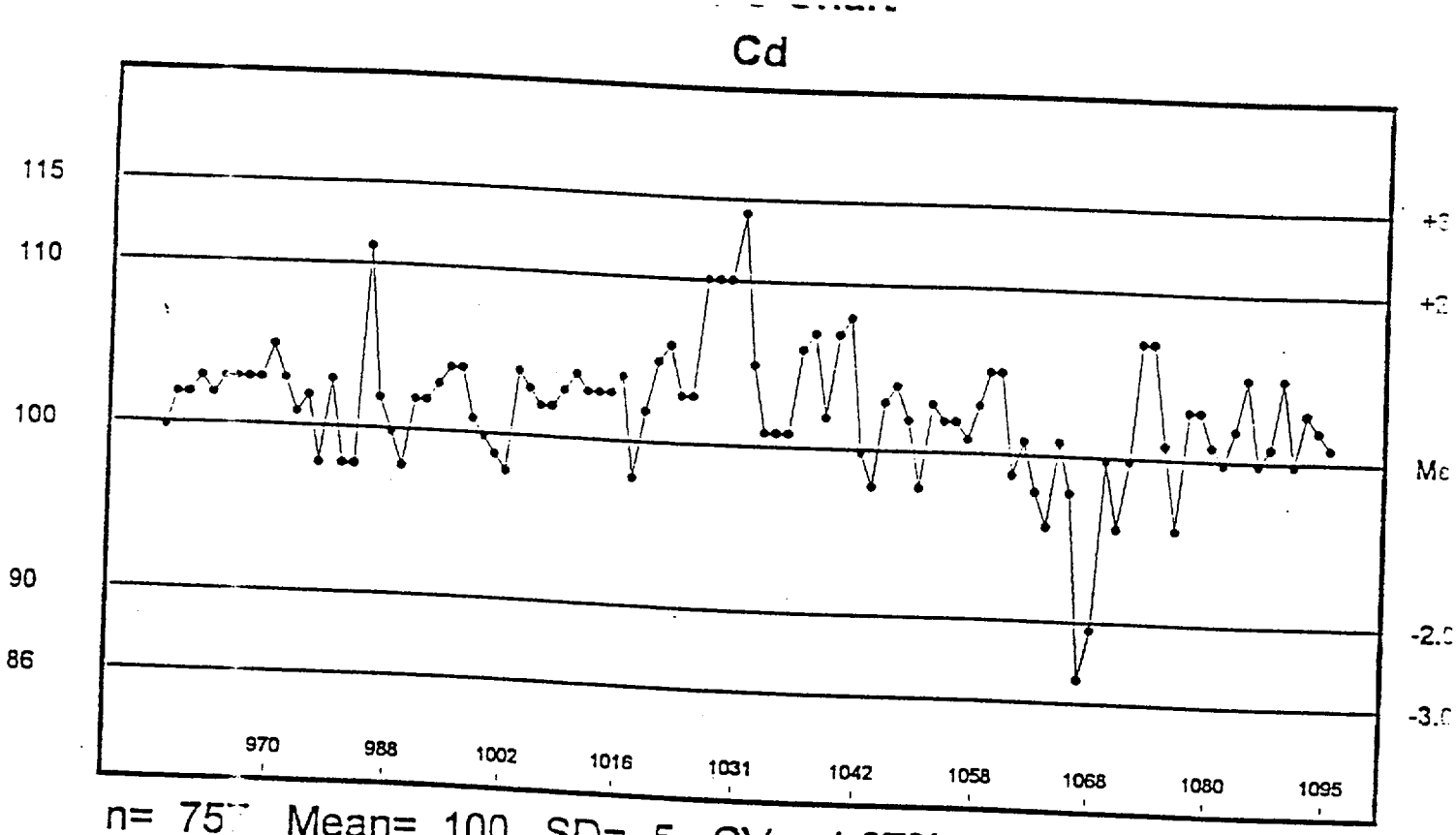

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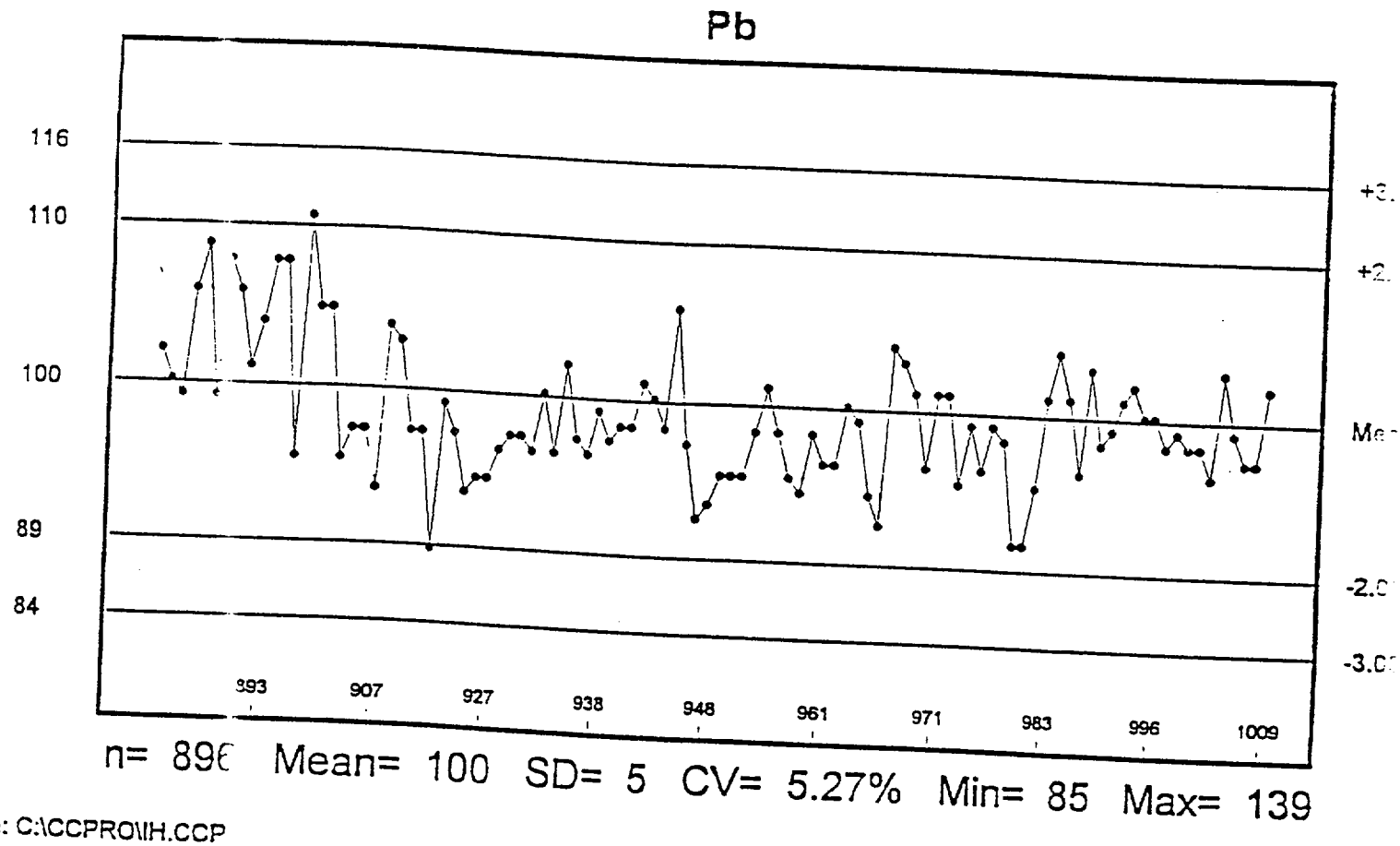
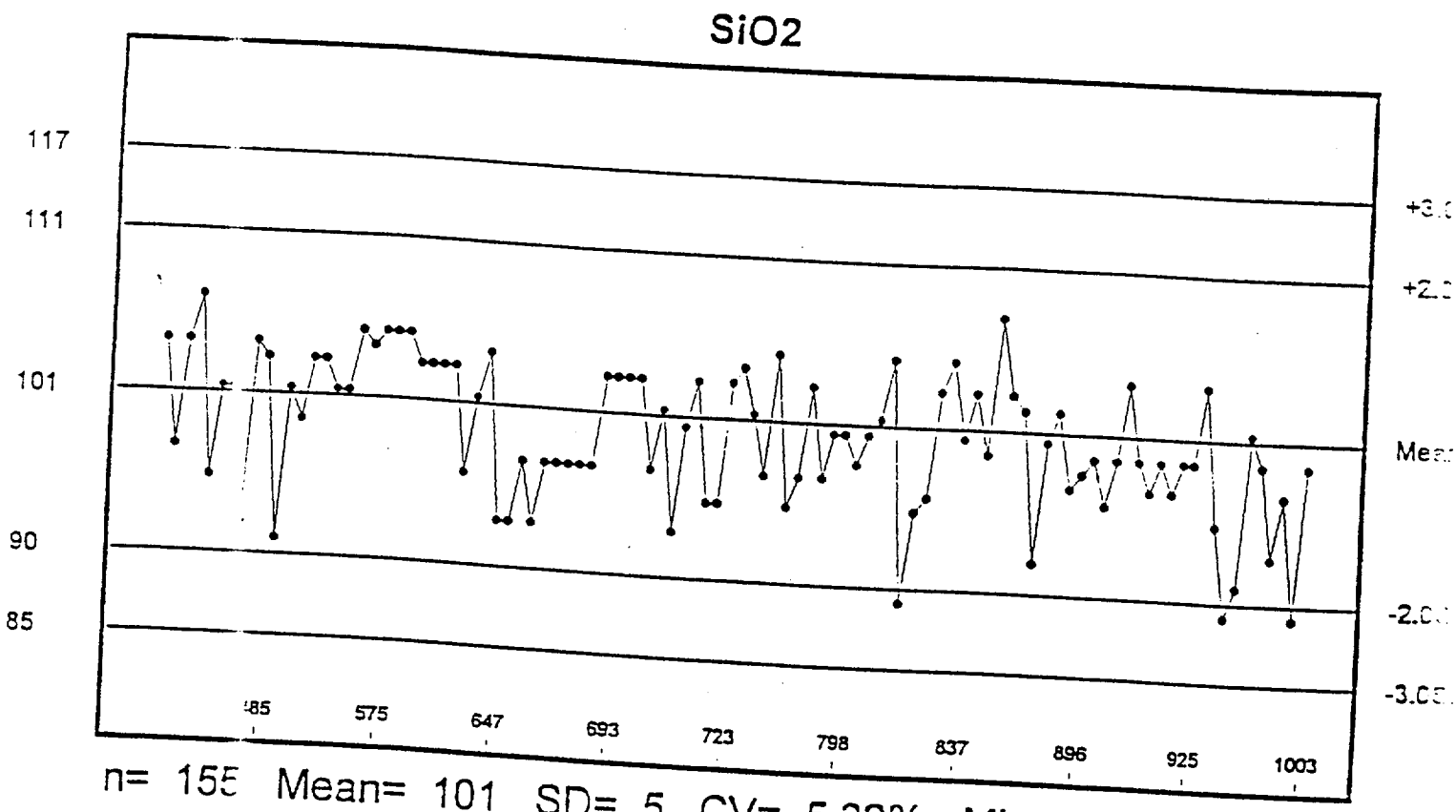
File: C:\CCPRO\IH.CCF

Column Cd



File: C:\CCPRO\IH.CCP

Column Pb



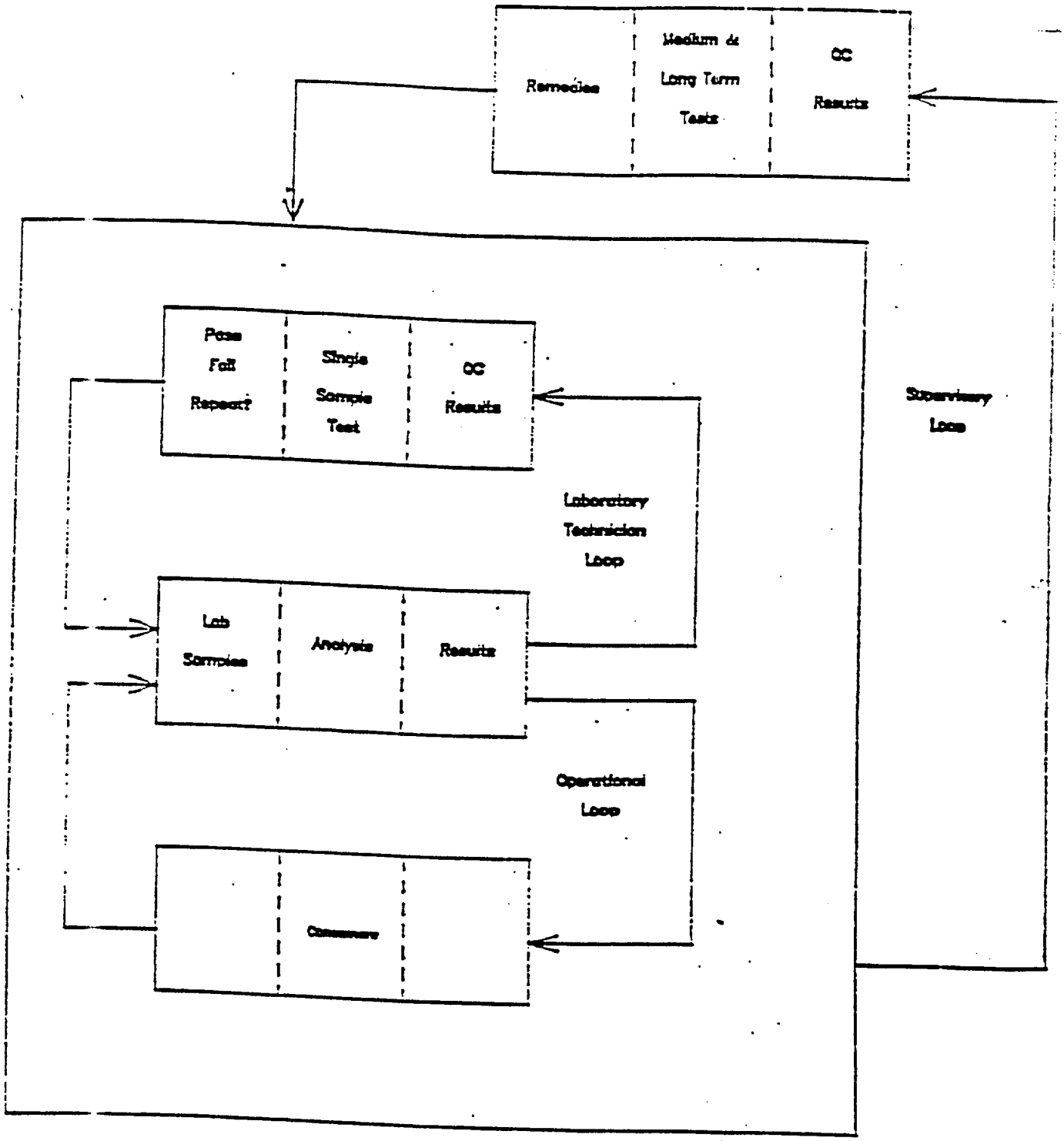
n= 155 Mean= 101 SD= 5 CV= 5.32% Min= 88 Max= 117

File: C:\CCPRO\IH.CCP

Column SiO2

ATTACHMENT 10

CONTROL LOOP


Remedies
Medium &
Long Term
Tests
QC
Results
Pass
Fail
Repeat?
Single
Sample
Test
QC
Results
Supervisory
Loop
Laboratory
Technician
Loop
Lab
Samples
Analysis
Results
Operational
Loop
Consumers

ATTACHMENT 11

STANDARDS LOG

Optima 3000 DV Standards Log #26

Calibration Standard #1

Environmental Resource Associates ICP Calibration Standard #3
Lot #1097
1.0 ppm Ba, Be, Cd, Cr, Co, Cu, Mn, Mo, Ni, Pb, Sb, V and Zn
10 ppm Al, Fe, Mg and Se
In 0.5%, v/v, HCl and 0.5%, v/v, HNO_3

In use from December 3, 1997 to present.

Calibration Standard #2

50 ppm Ca
Mallinckrodt $CaCO_3$ (99.85%) lot #CXN. From 1000 ppm stock prepared April, 1995 by GJS.
In 10%, v/v, HCl

In use from January 16, 1998 to present

Calibration Standard #3

1 ppm As^{+5}
NBS 83c As_2O_3. From 1000 ppm stock prepared September, 1995 by GJS.
In 10%, v/v, HCl

In use from February 27, 1998 to present

Calibration Standard #4

5 ppm Ag
J.T. Baker $AgNO_3$, lot #45088. From 1000 ppm stock prepared December, 1996 by GJS.

5 ppm Tl
$TlNO_3$, lot #1-80. From 1000 ppm stock prepared April, 1995 by GJS.

In 10%, v/v, HCl

In use from October 16, 1997 to present

Calibration Standard #5

50 ppm K
J.T. Baker KCl, lot #58.0.0. From 1000 ppm stock prepared March, 1996 by GJS.

50 ppm Na
J.T. Baker NaCl, lot #57.0.0. From 1000 ppm stock prepared December, 1995 by GJS.

In 10%, v/v, HCl

In use from February 19, 1998 to present

Calibration Standard #6

5 ppm Au
ASARCO Central Research Au metal (99.99+%). From 1000 ppm stock prepared June, 1996 by GJS.
In 10%, v/v, HCl

In use from February 11, 1998 to present

ANALYST: JJT DATE: 4-27-98

SAMPLE SOURCE: Class C980679-33 to 39. UPCM C980754-1; C980755-1 to 2. Caddis C980758-1. Lacsmo C980786-1 to 3. BioTrace C980808-1 to 2. East Helena C980862-1 to 6. El Paso C980825-1 to 6. Envirotech C980823-1 to 2. El Paso C980778-1 to 4; C980792-1, C980794-1 to 4; C980793-1 to 4. Certified Castings C980846-1 to 3. East Helena C980712-1 to 90.

STANDARDS LOT #: Calibration Standards #1, 2, 3, 4, 5, 6 & 7.

ANALYST: JJT DATE: 4-28-98

SAMPLE SOURCE: El Paso C980858-1 to 4. East Helena C980814-1; C980712-91 to 185.

STANDARDS LOT #: Calibrated Standards #1, 2, 3, 4, 5, 6 & 7.

ATTACHMENT 12

ANALYTICAL REPORTS

ASARCO

December 22, 1998

Mr. [redacted]

Please find attached the analytical results for the HDS water sample collected December 14, 1998.

The sample was received by the laboratory on December 18, 1998.

Results were faxed to you on December 22, 1998.

Sincerely,

John H. Nokes
Laboratory/Environmental
Technician

cc: GRStanga (w/attach.)
JLloyd "
Ramachandran "

ASARCO TECHNICAL SERVICES CENTER

ANALYTICAL DATA REPORT

[redacted]

Water and Solid Waste (Project 3119)

Batch No: L982521

LAB NO	DATE COLLECTED	DESCRIPTION		PARAMETER	VALUE	UNITS	ANALYST	DATE ANALYZED	HOLD DAYS	METHOD
L982521-1	14-DEC-98	HDS-E001	HDS Effluent	AS(TR)	.11	ppm	BD	21-DEC-98	180	6020
				CD(TR)	.001	ppm	BD	21-DEC-98	180	6020
				CU(TR)	<.010	ppm	BD	21-DEC-98	180	6020
				FE(TR)	.61	ppm	JJT	18-DEC-98	180	6010
				HG	<.60	ppb	VPK	22-DEC-98	28	245.1
				PB(TR)	.005	ppm	BD	21-DEC-98	180	6020
				SE(TR)	.95	ppm	BD	21-DEC-98		6020
				TL(TR)	2.2	ppm	JJT	18-DEC-98	180	6010
				ZN(TR)	.61	ppm	JHN	18-DEC-98	180	289.1

[illegible]05 method of preparation for (TR) metals.

Vince [illegible]
Approved

[illegible]
Reviewer

ASARCO TECHNICAL SERVICES CENTER

ANALYTICAL DATA REPORT

[redacted]

Water and Solid Waste (Project 3119)

Batch No: WG981540

LAB NO	DATE COLLECTED	DESCRIPTION		PARAMETER	VALUE	UNITS	ANALYST	DATE ANALYZED	HOLD DAYS	METHOD
G981540-1		Matrix Spike	L982521-1	AS(TR)	103.	% RECOVERY	BD	21-DEC-98		6020
				CD(TR)	97.	% RECOVERY	BD	21-DEC-98		6020
				CU(TR)	91.	% RECOVERY	BD	21-DEC-98		6020
				FE(TR)	104.	% RECOVERY	JJT	18-DEC-98		6010
				HG	82.	% RECOVERY	VPK	22-DEC-98		245.1
				PB(TR)	103.	% RECOVERY	BD	21-DEC-98		6020
				SE(TR)	110.	% RECOVERY	BD	21-DEC-98		6020
				TL(TR)	97.	% RECOVERY	JJT	18-DEC-98		6010
				ZN(TR)	106.	% RECOVERY	JHN	18-DEC-98		289.1
981540-2		Duplicate	L982521-1	AS(TR)	<1.0	% RPD	BD	21-DEC-98		6020
				CD(TR)	9.5	% RPD	BD	21-DEC-98		6020
				CU(TR)	13.6	% RPD	BD	21-DEC-98		6020
				FE(TR)	<1.0	% RPD	JJT	18-DEC-98		6010
				HG	<1.0	% RPD	VPK	22-DEC-98		245.1
				PB(TR)	<1.0	% RPD	BD	21-DEC-98		6020
				SE(TR)	2.1	% RPD	BD	21-DEC-98		6020
				TL(TR)	3.3	% RPD	JJT	18-DEC-98		6010
				ZN(TR)	1.6	% RPD	JHN	18-DEC-98		289.1
981540-3		Laboratory Control	EEICQ-50/FSHR	AS(TR)	107.	% RECOVERY	BD	21-DEC-98		6020
				CD(TR)	101.	% RECOVERY	BD	21-DEC-98		6020
				CU(TR)	95.	% RECOVERY	BD	21-DEC-98		6020
				FE(TR)	98.	% RECOVERY	JJT	18-DEC-98		6010
				HG	91.	% RECOVERY	VPK	22-DEC-98		245.1
				PB(TR)	105.	% RECOVERY	BD	21-DEC-98		6020
				SE(TR)	112.	% RECOVERY	BD	21-DEC-98		6020
				TL(TR)	97.	% RECOVERY	JJT	18-DEC-98		6010
				ZN(TR)	98.	% RECOVERY	JHN	18-DEC-98		289.1
[illegible]-4		Prep Blank	12/18/98	AS(TR)	<.005	ppm	BD	21-DEC-98		6020
				CD(TR)	<.001	ppm	BD	21-DEC-98		6020
				CU(TR)	<.010	ppm	BD	21-DEC-98		6020
				FE(TR)	<.020	ppm	JJT	18-DEC-98		6010
				HG	<.60	ppb	VPK	22-DEC-98		245.1
				PB(TR)	<.003	ppm	BD	21-DEC-98		6020
				SE(TR)	<.005	ppm	BD	21-DEC-98		6020
				TL(TR)	<.020	ppm	JJT	18-DEC-98		6010
				ZN(TR)	<.020	ppm	JHN	18-DEC-98		289.1

ASARCO TECHNICAL SER _S CENTER

ANALYTICAL DATA REPORT

[redacted]

Water and Solid Waste (Project 3119)

Batch No: WG981540

LAB NO	DATE COLLECTED	DESCRIPTION	PARAMETER	VALUE	UNITS	ANALYST	DATE ANALYZED	HOLD DAYS	METHOD
81540-5		Practical Quantitation Limit	AS(TR)	.005	ppm				6020
			CD(TR)	.001	ppm				6020
			CU(TR)	.010	ppm				6020
			FE(TR)	.030	ppm				6010
			HG	.60	ppb				245.1
			PB(TR)	.003	ppm				6020
			SE(TR)	.005	ppm				6020
			TL(TR)	.020/.003	ppm				6010/6020
			ZN(TR)	.020	ppm				289.1

Approved

Reviewer

Section 1.1
Frontier Geosciences' Quality Assurance

1.1.1 Frontier Geosciences' QA Policy Statement

Quality Assurance (QA) is a system for ensuring that all information, data, and interpretation resulting from an analytical procedure are technically sound, statistically valid and appropriately documented. Quality Control (QC) is the mechanism used to achieve quality assurance.

Frontier Geosciences Inc. (Frontier) has a strong commitment to quality assurance, both at the bench and the management level. Frontier realizes that without quality control, data may become suspect and of less value to our client. Frontier is therefore dedicated to producing data of highest quality, usability, and coherence.

Data quality is achieved through Frontier's Data Quality Objectives (DQO's). Our DQO's consist of five components: precision, accuracy, representativeness, comparability and completeness (PARCC).

- Precision is a measure of how repeatable data is and is often measured by sample replicates.
- Accuracy is a measure of how close the data is to the actual, or real value, measured by certified reference materials and matrix spikes.
- Representativeness is a measure of how representative a sample is to the sample population and is achieved by accurate, artifact-free sampling procedures and appropriate sample homogenization.
- Comparability looks at ongoing projects and how variable one set of data is to another. Comparability helps to measure the scientific coherence of the system to past work .
- Completeness is a measure of how many data points collected are usable; Frontier considers 95% usable data to be an acceptable value for completeness.

Frontier routinely provides data packages in one of three QA formats. The first, called "Screening Level", is equal to US EPA Level 1. "Research Level" is between US EPA Levels 2 and 3, while the third, called "Litigation Level" is approximately equivalent to the US EPA Level 4. In addition, Frontier will provide custom QA/QC packages to meet the individual needs of the client. The various QA/QC levels above "screening level" do not represent differences in analytical data quality, but rather, the degree of documentation provided, and therefore the ability to defend the data in legal proceedings. The quality of the data produced under QA reporting schemes above the screening level, as measured by quantitative indicators such as precision, accuracy, and detection limits, are equivalent.

1.1.2 Frontier Geosciences' Quality Assurance Policy

Frontier recognizes that accurate and precise data depends upon an effective and consistent QC program. Frontier's program is implemented collaboratively by the entire laboratory group and subscribes to the following basic tenets:

Sample integrity must be preserved. Integrity is preserved by following documented sample handling procedures for the preservation, custody, storage, labeling and record keeping of samples received by the laboratory.

Trace metal-free ("ultra-clean") sample handling must be employed. All samples to be analyzed for low level or ambient metals concentrations are handled according to protocols: including the use of our class-100 clean room, wearing of clean room gloves, and using only pre-tested and approved reagents, water, and equipment. High-level (contaminated) samples are kept segregated from ultra-clean samples during storage and sample preparation.

Approved analytical methods must be followed. The analyst's fundamental understanding of analytical methods is paramount for effective, first-defense QC. Emphasis on understanding and following the correct methods is part of every analyst's training. QC results from each method are evaluated to identify and correct method weaknesses, and to detect any need for further training.

Analytical instrumentation must be in proper working order. Optimum instrument performance is assured by the use of daily calibration and performance evaluation samples. Rigorous preventative maintenance is performed on a regular basis and is well documented.

Raw data must be properly reduced and accurately transcribed into the correct reporting format. Various levels of data review, from acquisition to the final report, are performed to minimize error.

The laboratory-specific precision and accuracy of analytical methods must be documented and monitored continuously. Accuracy and precision are monitored and compared to historical data from Standard Reference Materials (SRM's). All data is scrutinized according to our scientific understanding of the biogeochemistry of the particular situation. **The scientific coherence of the data set is considered to be as important a QA parameter as precision or accuracy.**

Section 1.2
Corporate Ethics Policy on Fraud, Waste, and Abuse

1.2.1 Environmental Responsibility

As an environmental science research company and specialty laboratory, Frontier aspires to be a model of environmental responsibility. Thus, employees should be ever-vigilant to avoid waste, conserve resources, reuse, recycle, and minimize the production of hazardous wastes. The procedures used in a modern scientific laboratory often employ toxic materials and disposable items. Therefore, employees are encouraged to develop innovative ways to minimize the production of these materials, while finding safe ways to reuse disposed of items (plastic bags, bottles, unused chemicals, etc.), once their laboratory usefulness is finished.

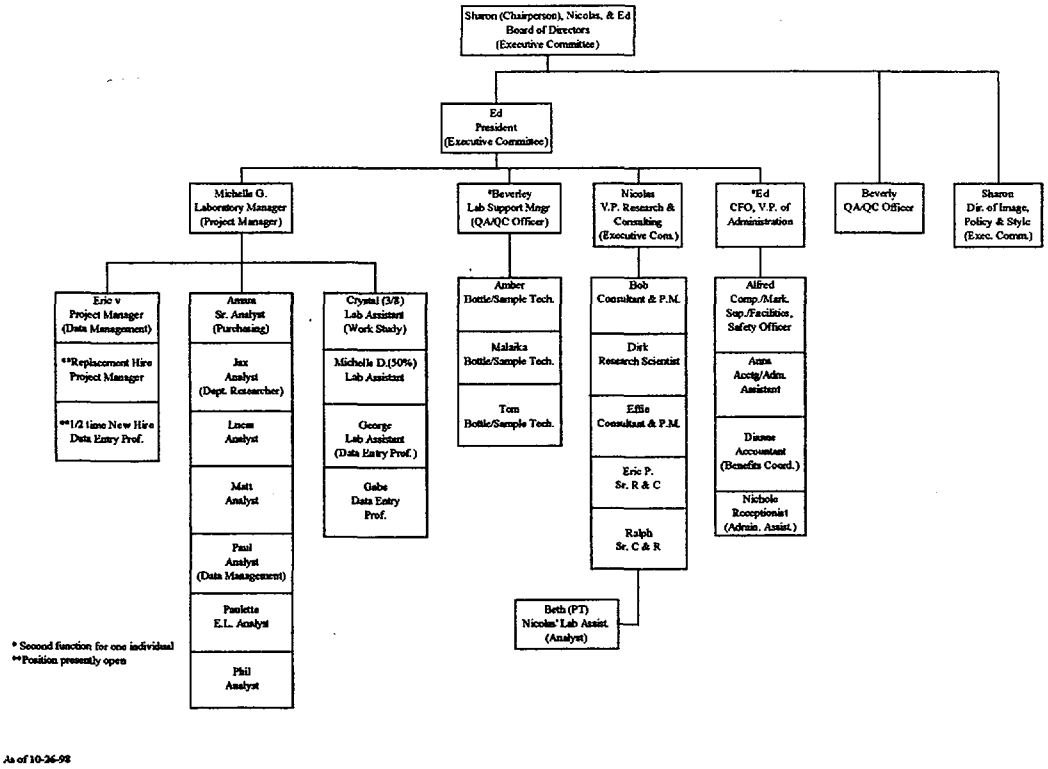
1.2.2 Intellectual Honesty

Frontier performs environmental research for government, industry, academic institutions, and environmental activist groups. Hence, it is important for the company's credibility that all reported results and interpretations be objective and honest. Although individuals within the company may differ on the political implications of various results, Frontier must remain above this in its data and research. All obtained results must be reported with complete honesty, with no regard to the expected, or preferred (by client or researcher) outcome. In the case of researcher-selection of "best" or "most accurate" data from an analytical set, all assumptions used in choosing data or rejecting data, must remain readily available to the sponsor and/or outside review. Fabrication of data or its deliberate misinterpretation is considered grounds for immediate employment termination.

All employees are required to adhere to Frontier's Intellectual Honesty policy. Any employee witnessing an act that may be considered to go against the Intellectual Honesty policy is required to report the instance to management. The reporting employee may maintain anonymity. Several avenues are available to employees wishing to report suspect behavior: they may directly confront the offending employee, they may report the instance to the employee's direct supervisor, the lab manager, the president or the QA officer. There may be times when the decision to reject data is not absolutely clear. Any time the decision is ambiguous, the decision must be made with management consent. Unambiguous decisions need not be overseen, or explained, but all data must be presented and noted on the original data set. The important factor is that management become aware of the situation and that all employees feel comfortable reporting suspect behavior.

Section 2.1
Frontier Geosciences' Organizational Chart

Frontier Geosciences Inc.



Frontier subscribes to a relaxed hierarchy, where teamwork is more important than job status. The lab manager oversees the entire lab on a day to day basis. All technical employees report to the QA officer and lab manager about QA issues. The lab manager is able to answer questions regarding quality assurance issues if the QA officer is out. The QA officer works with the lab manager to implement and assure QA policies.

Laboratory personnel are responsible for quality control at the bench level. Frontier considers the analyst as the first line of defense. Quality control is then looked at by the lab manager. Finally, each dataset's quality control measures are reviewed by the QA officer, who is the last line of defense for quality control before the data is sent to the client. The client performs a final review of the data when he/she receives it. For projects less than level 4 QA, the samples may be discarded after the project manager and QA officer have reviewed the data, but before the client has done so (unless special provisions for sample archiving were made in advance). For litigation level QA work, any requests to re-run the sample must come within one month of report submission. If re-run results are equivalent to initial results, the client assumes responsibility for paying for the

extra work. Frontier will answer QC related questions after one year of report submission if the client is willing to pay for the time.

In addition, if any employee feels that the appropriate person is not fixing a given problem, the employee may speak to the lab manager or QA officer, enlisting their aid in getting the issue resolved.

Section 2.2
Frontier Geosciences' Personnel Qualifications

Scientific Staff	Highest Academic Degree	Responsibilities
Nicolas S Bloom, Sr. Research Scientist	MS Oceanography 1987	mentoring, business dev., supervision, research
Ralph R. Turner, Sr. Research Scientist	PhD Oceanography 1975	research, consulting, field work
Eric M. Prestbo, Research Scientist	PhD Chemistry 1992	research, consulting, field work
Efrosini Tsalkitzis, Research Scientist	MS Biology 1995	research, consulting, staff biologist
Dirk Wallschläger, Post-Doc Researcher	PhD Natural Sciences 1996	research, methods development
Robert C. Brunette, Research Scientist	BS Chemistry 1993	research, consulting, field operation
Michelle L. Gauthier, Lab Manager	BS Chemistry/Physics 1992	laboratory management, project management
Eric J. von der Geest, Project Manager	BS Chemistry & Math 1993	mercury project management, computer resource
Amara M. Vandervort, Sr. Analyst	BS Biology & Psychology 1994	sample prep and analysis supervision, field work
Jacqueline G. London, Analyst, Research Specialist	BS Chemical Engineering 1996	sample prep and analysis, research
Paul Laskowski, Analyst	BS Chemistry 1990	sample prep and analysis, computer resource
Matt Horrobin, Analyst	BS Honors Biology 1989, PGCE	sample prep and analysis
Phil Kilner, Analyst	BS Environmental Science 1997	sample prep and analysis
Lucas Hawkins, Analyst	BS Chemistry 1993	sample prep and analysis
Paulette Jones, Entry-Level Analyst	MS Environmental Science 1997	sample prep
George Scriba, Lab Assistant, Data Entry Prof.	BS Environmental Science 1996	sample prep, misc. laboratory duties, data entry
Crystal Howard, Lab Assistant (student)	BS Geology 1999 (to be awarded)	sample prep, misc. laboratory duties
Gabriel Choy, Electronic Data Deliverables Specialist	AA Art 1996	data entry, peer-review of datasets
Michelle Dedman, Lab Assistant	BS Zoology 1982	sample prep, misc. laboratory duties
A. Malaika Lafferty, Technical Specialist & Sample Custodian	High School Diploma	laboratory equipment processing, sample receiving, shipping
Amber Steward, Technical Specialist & Sample Custodian	BS Geological Oceanography 1998	laboratory equipment processing, sample receiving, shipping
Thomas E. Smith, Technical Specialist & Sample Custodian	High School Diploma	laboratory equipment processing, sample receiving, shipping

Administrative Staff	Academic Degree	Responsibilities
Sharon K. Goldblatt, CEO	BS Human Development 1987	P.R., administration, marketing, editing
Ed G. Geiger, President & CFO	MBA (CPA, Retired) 1983	financial mgt., administration, marketing
Beverly A. Heaphey, Quality Assurance Officer	BA Philosophy 1990	quality assurance and control
R. Dianne Shepard, Accountant & Benefits Admin.	BA Education 1974	accounts receivable, payroll, general ledger
Anna M. Cortez, Administrative Assistant	AA General Studies 1992	administrative duties, accounts payable
Alfred Rordame, MIS, Safety Officer	BUS Choreography and Composition 1983	safety coordination, facilities mangmnt, computers, graphics

Section 2.3
Facility Description and Capital Equipment

2.3.1 Facilities

Frontier's laboratory and office facilities are in downtown Seattle, Washington. The location is close to Sea-Tac Airport, and the University of Washington.

The space contains a small (100 ft^2), clean room, four mercury analysis laboratories (c.a. 500 ft^2 each), four sample preparation rooms (c.a. 200 ft^2 each), two graphite furnace AA laboratories, an ICP-MS laboratory, an atmospheric reactions laboratory, a conference room/library, and ten staff offices.

The laboratories are served by a custom-designed HVAC system with ESP pre-cleaners, providing an atmosphere that is clean and well isolated from outside dust and dirt. Each laboratory atmosphere is routinely monitored for Hg in the gas phase, and appropriate action is taken if it exceeds 25 ng/m^3 in any location, or 10 ng/m^3 in the clean room. Frontier uses an acid neutralization discharge systems for liquid acid-waste disposal. Disposal of toxic materials is carried out under contract to a certified disposal company.

The offices are equipped with document production equipment: laser printers, document and image processing software, color printer, large capacity collating copier, and a binding machine. A network connects personnel computers and printers for local access, as well as allowing for external email and faxes. Frontier has a Fed-Ex Powership shipping computer and access to Fedex pick-up as late as 5:00 PM Pacific Coast time.

The entire Frontier space has been inspected and passes all city and state code requirements for fire, emissions, and low level radioactive samples.

Frontier owns all necessary equipment for ultra low level trace metal research.

2.3.2 Security

Access to Frontier offices and laboratories is regulated and limited to authorized personnel. During normal work hours, when the front office is staffed, visitors are required to check in and sign the guest list if they have not previously done so. All visitors, including delivery personnel, must be accompanied by an employee in the laboratory. The outside front door and the two back doors are kept locked at all times. Visitors must first press the Frontier button on the building's security door buzzer system outside the main entrance, identify themselves, and then be admitted by an employee-actuated electronic door lock release.

All computers are backed up five days per week onto the main system, which is stored in a fire-proof safe. Backup tapes are rotated on a five day schedule, so that at all times backups are insured for the last five business days. Once a month, a tape is taken to a safety deposit box and stored there.

Employee safety is an important concern to Frontier. In addition to the overall facility security system, Frontier also has two remote alarms. The alarms are worn around the neck, and alert the police when activated.

2.3.3 Frontier Geosciences' Capital Equipment

Qty.	Description	Manufacturer
4	Cold Vapor Atomic Fluorescence Hg Detector	Oriel/Frontier-built
3	Cold Vapor Atomic Fluorescence Hg Detector	Tekran
4	Isothermal GC for Hg Speciation	lab-built
2	0.1 mg Analytical Balance	VWR
2	0.01 g Lab Balance	VWR
2	Class 100 Clean Air Hood (4' and 2')	Labconco
4	Class 100 Clean Bench (6' with gold Hg scrubber)	Labconco
1	Milli-Q 50 Reagent Water System	Millipore
2	Ultra-Pure Reagent Water System	US Filter
1	Large Volume Water Deionization System	US Filter
10	Macintosh Computer (networked + e-mail)	Apple
23	IBM Compatible Computer (486 processor)	Toshiba
1	Zeeman 5000 GFAAS + Hydride System	Perkin-Elmer
1	4' Hg-Free Nitrogen-Purge Glove Box	Labconco
1	Large Volume Centrifuge (250 mL bottle)	Centra
1	Tungsten Carbide Ball Mill	Spex
6	Dual Pen Chart Recorder	Kipp & Zonen
2	Chromatographic Integrator	Hewlett-Packard
7	Constant Temperature Lab Ovens	Precision
6	5 Tube Methyl Hg Distillation Units	lab built
2	Muffle Furnace	Precision
6	Refrigerator/Freezer (sample storage)	Whirlpool
5	Complete sets of fluegas sampling equipment	Frontier-built
24	Teflon® bulk deposition collectors	Frontier-Built
>500	Ultra-Clean Teflon® Bottles, various sizes	Nalgene
>1000	Ultra-Clean Teflon® Vials, various sizes	Savillex
1	Dissection Microscope	Leica
1	Specific Ion/Conductance/pH Meter	Orion
1	UV-VIS Spectrophotometer	Spectronic
1	Low Level Ozone Analyzer/Calibrator	Dasibi
10	Digital Mass Flowmeter	Sierra
1	4110 ZL Atomic Absorption Spectrometer	Perkin-Elmer
1	ICP-MS ELAN-6000	Perkin-Elmer
1	PSA "Excalibur" HGAFS system (As, Se, Sb)	PSA

Section 2.4
Frontier Geosciences' Preventative Maintenance

The responsibility for preventative maintenance belongs to the laboratory group leader. Verification that preventative maintenance is being performed is the responsibility of the QA Officer. Logbooks for each instrument are maintained, and a central file is located in the QA officer's office to document major actions. Preventative maintenance procedures are laid out according to the type of instrument.

Mercury Analyzers:

Daily - Make sure work area is clean
Check all traps and bubblers for particulate contamination
Clean bubblers at the end of the analytical day
Monitor gold trap performance for blanks, reproducibility, recoveries
Test and/or replace degraded traps as needed
Every 3 months - Thoroughly clean analyzer

AA:

Daily - Clean contacts
Clean analyzer windows
Weekly - Compare slopes
As needed - Routine service contract for cleaning, testing and/or service

Balances:

Daily - Check with ASTM Class 1 weights
Every 6 months - Certified calibration performed

Pipettes:

Weekly - Calibration checked
As needed - Pipettes are taken apart and cleaned

pH meters:

Before each use - Calibration checked
Every 6 months - Certified calibration performed

Clean Hoods:

Weekly - Outside air filters cleaned
Monthly - Pre-Hepa filters checked
As needed - Pre-Hepa filters changed

Section 3.1
Frontier Geosciences' Corrective Action

3.1.1 Qualified Data Corrective Actions

In the event that a breech of security or other out-of-control event occurs before sample receipt at the laboratory (e.g., custody seal is broken, samples received do not match the COC, cooler temperature or preservation status not as specified in SOW or COC, etc.), the discrepancy will be noted in the receiving logbook, on the COC form, and in the project file, by the sample custodian. The project manager or laboratory manager will then be immediately notified. The manager will contact the client immediately, via fax or telephone, to decide upon a plan of action. In the intervening time until the client can respond, the samples will be held in secure storage under conditions appropriate for the sample type (i.g., in refrigerator for water samples, in freezer for frozen samples, etc.). If the client cannot be reached within reasonable sample storage time, the analyst and lab manager will use their best judgment on deciding what course of action to take.

If there is any suspicion that a sample set may contain radioactive, dangerous or toxic materials, high levels of gaseous mercury, unsterilized human or primate blood, tissues, excreta, or any other threat to the health or cleanliness of the laboratory or its staff, the sample container will be immediately closed up, placed in a secure storage area outside the building, and the safety manager immediately notified. The client will be immediately contacted via fax or telephone, to decide upon a plan of action. Under no circumstances will processing or analysis of the samples begin until the client can certify the safety of the materials. If the client cannot do so, the samples will be returned exactly as received.

3.1.2 Analytical Issues

Any data that is analytically suspect due to laboratory problems, biogeochemical improbability, poor precision or accuracy on QA samples will be qualified (flagged) and an explanation will be included in the case narrative. If the sample is re-analyzed, all results will be presented on the original data set with an explanation as to why the laboratory selected specific certain results over others. It is initially the task of the analyst to identify any out-of-control occurrences and immediately notify her/his supervisor and/or the lab manager, to obtain further instructions. If the incident appears to be a unique random occurrence (e.g., a low LCS recovery) the sample will be re-run as soon as possible. If upon re-running the sample an acceptable result is obtained, and no other out-of-control events occur in the data set, the data set will be considered valid and in control. If multiple out-of-control QC results, and poor system calibration, or any other suspected systematic analytical problems are observed, the analyst will immediately suspend further analysis, and contact the project or laboratory manager. The analyst, under the manager's direction, will then investigate the probable causes of the system failure, correct them, and then successfully re-calibrate and QC-test the system before continuing to analyze samples. Occurrences of this type will be noted in the case narrative, and all

data collected while the system was out-of-control will be either discarded or reported and flagged and the instance noted in the corrective action file.

Once the data has been checked and found to be in control by the analyst, it is submitted to the project manager, who makes the formal calculations of results, notes any QC sample discrepancies (low SRM's, high blanks, etc.), and any problems generated from field QC samples (field duplicate precision), or problems related to scientific coherence (i.e., out-of-place results in a depth vs. concentration plot, methyl Hg higher than total Hg, etc.). For suspect samples, the raw data and analyst notes are first consulted to help resolve the discrepancy (i.e., is it plausible that the error is due to a sample labeling mix-up, transcription error, etc.?). If the project manager feels that one or more samples should be re-analyzed based upon his/her evaluation, a written note is placed in the project file, and a re-analysis request is made to the analyst. When the re-run results are evaluated by the project manager, she/he will make a decision as to which data to retain or flag, and that will be noted in the case narrative.

3.1.3 Data Package Verification

On litigation level QA projects, before submission of final results to the client, the raw data package and calculated results are submitted to the QA officer. The QA officer or his/her delegate checks over the package to be sure all QC samples have been run and are within internal and/or client specifications. An exception to this would be for fast turn-around-time projects, when an "un-revised" report is initially sent and then later backed up with a reviewed, revised version. At this time, approximately 5% of the calculations are rechecked for errors. If none are found, the package is cleared for final submission. If errors are found, the entire package is rechecked, and a memo of discrepancies is sent to the project manager for rectification. The project manager then writes the final report, noting any unresolvable QC issues, and qualifying any data, if necessary, in the case narrative.

On some litigation level QA data packages, the final step in the QA/QC process occurs with the independent validation of the data package by the client. If discrepancies or concerns are noted by the independent validator, they are communicated in a formal letter to the project manager, who then investigates and explains each result in a formal response. If any of the results are changed (e.g., due to calculation or transcription errors), the affected pages of the final report are modified, annotated with the revision date, and re-submitted. It is Frontier's convention to report all data to one more significant figure than is warranted by the precision and accuracy of the methods employed (typically three figures). **It is further the position of Frontier that discrepancies of up to 5 units in the last significant figure, typically attributable to numerical rounding differences between Frontier and independent QC validators, need not be rectified, as they are meaningless to the interpretation of the data. This position results in significant savings in personnel resources for both Frontier and the client.**

3.1.4 Sample Re-Analysis

Frontier will normally, if sufficient sample volume remains and if the degree to which the samples are out-of-control warrants, re-analyze, at our cost, all suspect results on our own initiative. Upon agreement of the sponsor, we will also re-run analyses at sponsor request, but if the re-run data supports the notion that poor results were due to natural or client causes rather than laboratory causes, the client must pay for those additional requested analyses. Further, it is our position that if data is slightly outside QC bounds, but that lower quality does not materially affect the overall data interpretation, the results should not be re-analyzed at Frontier cost, but rather flagged as approximate.

3.1,5 Corrective Action Reports

In all cases where investigation by the project manager or the QA officer results in data being changed, qualified, or in samples being re-analyzed, a written note will be placed in the client file, and a copy placed into a chronological "Corrective Action File" maintained by the QA officer. These reports are the basis for corrective actions by the project manager and her/his staff, and for notations in the project case narrative. Once the QA issue has been investigated, resolved and/or corrected, a response describing the course of action and final result is appended to the original corrective action report.

Infrequent, random, and singular out-of-control events (e.g., a single low spike recovery), which are not part of a trend, are not considered evidence that the system is out-of-control. However, the QA officer must keep a record of such events (in control charts, for example), to assure that their frequency is maintained at less than 5% (running average n>100 occurrences). Occurrences of greater than 5% random deviations from acceptable control limits in any monitored parameter are considered an "out-of-control" condition, and analysis is stopped until the cause is identified and rectified.

3.1.6 Control Charts

In addition to project-specific QC corrective actions, the project manager and QA officer will maintain records of key analytical parameters (i.e., SRM's, spike recoveries, RPD results, blanks) as control chart files. The control chart files are updated weekly, and control chart analyses conducted on a monthly basis. The QA officer or the project manager may elect to perform specific control chart analyses more frequently to ascertain if any trends in data quality are developing. Examples of data not included in control charts include: data from highly contaminated soils or other very inhomogenous materials, values close to the MDL, spikes too close to the sample concentrations, specialty (rarely used) and/or research-only methods, samples, etc.

Section 3.2
Frontier Geosciences' Laboratory Audits

3.2.1 Internal Audits

On a quarterly basis, the QA officer will conduct an internal laboratory audit, (FGS-041), via review of all control chart information, logbook entries, and client specific QA issues and corrective actions. In addition, he/she will take a detailed unannounced walk-through inspection of the laboratories, noting the QA and safety practices of the staff. Randomly requested data packages will be reviewed with the project manager to verify the accuracy and retrievability of particular data points, starting with raw data records (only litigation level data can currently guarantee this). The internal audit may also include submission of blind performance evaluation samples. These findings will then be evaluated by the QA Officer, reviewed by the laboratory manager, and discussed at a general staff meeting, with commendations and recommendations for areas of improvement. If any serious breaches of safety or QA practice (i.e., fire hazard, toxic fumes, poor calibration results, high water or air Hg levels, etc.) are noted during an internal audit or at any other time, all affected laboratory work will immediately be ceased, the health and safety officer notified and a meeting will be called to resolve the matter. Once the system has been brought back into control, routine work is allowed to continue and the incidence is noted as soon as possible in the corrective action file.

3.2.2 External Audits

Frontier views external audits as a form of free consultation and welcomes the opportunity to improve the quality of the lab. External audits are conducted at the discretion of the client, either prior to award of a contract, or as part of an ongoing laboratory monitoring process. Such audits may include submission of blind Performance Evaluation results, control chart information, data packages for complete independent validation, or a complete personal walk-through interview by the client QA representative. The laboratory may also be audited pending application for government certification, safety, or environmental regulation. Records of all such audits, their findings, and the corrective actions taken will be maintained in chronological order by the QA officer. In addition, health and safety related documentation will be retained by the health and safety officer. A copy of each project-specific audit will also be maintained by the project manager in the appropriate project file.

Performance Evaluations are performed twice a year. Samples from the Washington State PE program and from the APG program are analyzed and compared to other labs. In addition, other round-robin performance evaluations and regular performance evaluations will be conducted at the client's request or as deemed necessary by the lab manager.

Section 3.3
Quality Assurance Reports to Management

The QA officer is responsible for preparing a quarterly report. The purpose of the report is to present QA issues to the scientific staff in a condensed, graphical representation. The report should include at a minimum: changes in quality assurance, quality control changes, audit report findings, and control charts detailing current issues of interest or problem areas. The main objective of the monthly report should always be a tool to the scientific staff, helping them recognize trends and/or trouble spots. These quarterly reports should summarize and draw attention to quality control issues, both good and bad.

Section 3.4
Lab Documentation and Forms

Lab documentation and forms are created on an as-needed basis. The creator of the form is responsible for checking to see if the new form is replacing an old form. The new form is placed into the central Form Library and if it is replacing an old form, the old form is removed and discarded. The creator of the new form is also responsible for putting the new form into the computer system's file server. If it is replacing an old form, the old form is deleted (old forms are retained in back-up files). The creator of the new form then e-mails all staff informing them of the change.

All newly created forms are given a version number and date. This will assist staff and clients in recognizing current versus old forms. All newly created forms have Frontier's name on them, as well as the revision date and form number. If it is recognized that an old form is being used, then the person who noticed it is responsible for replacing the old form with the new version. It is the responsibility of all laboratory personnel to ensure that clients are receiving the new versions.

The QA officer maintains a document management file, wherein all major forms (i.e. SOP's, QAP's and QAM's) are logged out of the office so that when new versions are created, the correct persons may receive the new copies.

Section 3.5
Sub-Contracting of Services

On occasion, Frontier finds it necessary to sub-contract services for specialty analyses that we do not perform. We do not send overflow of samples within our expertise to outside labs. When this happens, Frontier will first contact the client and inform them of the situation and obtain their permission to sub-contract the work. Frontier will then contact laboratories that it usually uses and request their services. If they are not able to meet our needs, we will look for other laboratories. In either case, Frontier will remain ultimately responsible for the samples and results. Laboratory integrity and competence are of utmost importance and our paramount concern. When using another lab's services, Frontier routinely sends, along with the samples, blind spiked samples and

blanks to double-check and enforce the quality and integrity of the other laboratory's technical work. In addition, Frontier maintains a copy of the sub-contracted laboratory's quality assurance plan, performance evaluation results, and some of their benchsheets, to further ensure the quality of the other laboratory.

Section 3.6
Staff Training and Documentation

3.6.1 Hiring Process

People often begin their careers at Frontier as temporary employees provided by employment agencies. Under these circumstances, screening and reference confirmation is undertaken by the agency, and copies of that information are retained in the person's newly created employee folder. If/when the employee becomes permanently hired by Frontier, she/he signs the agency information, and those papers are returned to the personnel file. Even in situations where Frontier finds the employee directly, an employment agency may be used as a screening and payroll service for a temporary period.

New employees hired directly by Frontier provide documentation of skills they already possess via publications, detailed resumes, letters of recommendation, and self-certification. Subsequent staff training is documented via training checklists and written management and/or peer reviews, which are maintained in chronological order in the personnel files. Every staff member is formally evaluated quarterly using a combination of self and supervisor evaluation. Job descriptions are reviewed and may be updated at that time.

3.6.2 Training

Employees trained in a new skill learn by a mentorship process. The employee is assigned to a staff member, who teaches each method as follows:

a) First familiarization with the equipment/process by observation
b) Detailed reading of the SOP and attendant literature references
c) Second familiarization with the equipment/process by observation
d) Supervised practice of the method using standards and SRM's
e) Unsupervised practice of the method on standards/SRM's
f) Blind re-analysis of actual project samples, which have also been independently analyzed/processed by the mentor
g) Evaluation of the blind intercomparison by the new staff member, mentor, and laboratory manager.
h) Supervised analysis of low QC level samples or samples generated by internal research projects.

Completion of these steps is documented using a training checklist, signed by the trainee and by her/his supervisor. Once the new employee has successfully inter-compared on at least ten samples (i.e.; all results are found to replicate the mentor's results within ± 20%) he/she is considered trained in that task, and a note is placed in her/his personnel file.

For newly trained employees, pertinent QC data is reviewed on a daily basis by the laboratory manager or project supervisor for a period of at least one week, until the supervisor and/or laboratory manager is satisfied that the employee is competent in the procedure.

As the employee sets up her/his equipment and begins to obtain actual data, ongoing performance evaluations occur via control chart information, inter-laboratory intercomparison exercises, and blind Performance Evaluation (PE) samples documenting precision and accuracy. Records of performance are submitted by the staff member and/or supervisor (quarterly basis) to the lab manager, for inclusion in the staff member's personnel file.

Training documentation differs according to employment category. Principle Investigator's training is primarily documented by the quantity and quality of peer-reviewed literature and complete client reports. For technical staff, Frontier relies on documented analytical performance criteria (accuracy and precision on blind samples). Copies of all documentation are maintained by the QA officer.

3.6.3 Seminars and Meetings

Records are also maintained on all seminars, classes, and training sessions attended by each employee. On a yearly basis, all staff attend at least one safety seminar and one QA/QC review seminar, where current practices and new procedures are discussed and overall laboratory compliance is reviewed. In addition, Frontier holds monthly public seminars. The topic of the seminars varies from month to month and speakers may be invited from outside sources or may be internal staff. Finally, occasional, internal seminars are presented with speakers from outside the company or from within, on specific applied topics of interest.

In the event that any serious safety or QA/QC deficiencies are discovered by the lab manager, or if a new employee is hired, or if new project-specific requirements are mandated, a staff meeting will immediately be called to provide the appropriate information and establish any required protocols. The agendas from all Frontier staff meetings which include training issues, health and safety or discussion of QA/QC concerns will be signed by the attendees, and copies will be retained in personnel files.

Section 4.1
Frontier Geosciences' Sample Handling Procedures

4.1.1 Sample Receipt and Holding Time

Samples are delivered to the sample receiving area and may be accepted by any staff employee. Because the samples are sent by overnight carrier, signing the receipt and the COC form upon delivery fulfills the Chain-of-Custody requirement. The sample custodian opens the cooler, which may or may not be sealed with a client-supplied custody seal, checks the condition of the samples (intact, temperature, broken, leaking, etc.), and notes observations on the COC form and in the sample receipt log.

If the samples are from a contaminated or potentially radioactive site, the contents will be pre-monitored for the appropriate contaminants prior to unpacking by the health and safety officer. If the contents contain substances in concentrations which might contaminate the laboratory, endanger personnel or the environment, the container will be re-sealed, placed in a secure outside storage area, and the client notified.

The sample custodian verifies that each container is properly labeled and sealed, and compares the sample identification with the COC form. If Frontier bottle numbers are not utilized by the sampling crew, the sample custodian correlates these numbers with the client numbers directly on the COC form. If the sample identifications and the COC do not match, or if the seals on any of the containers are broken, the sample custodian notifies the laboratory supervisor.

4.1.2 Sample Tracking Procedures

Once the samples have been examined and their labels compared to the COC form, their information is entered into a master receipt logbook along with the client or project name, date and time received, matrix type, and any special client notes or anomalous observations. Each sample is assigned a unique laboratory sample identification number. In general, the sample tracking number is the client ID number, or, if the sample is in a Frontier provided Teflon® bottle, the engraved bottle number is the sample tracking number. Damaged samples are disposed of in an appropriate manner, and the laboratory supervisor and the project manager are notified (please see Frontier Geosciences' Hazardous Materials Management Plan for more information on sample disposal). The system for tracking samples through preparation and analysis consists of COC records, sample receipt logbook, project logbook, laboratory worksheets, laboratory notebooks, instrument operation logbooks, instrument printouts (raw data), and final analytical reports. Because the laboratory is small, secured, and the analysts/sample receipt personnel are in constant communication, no additional internal chain-of-custody documentation is maintained.

4.1.3 Sample Transport, Preservation and Storage

Special consideration is given to the procurement, storage, and transportation of samples to be analyzed. These procedures enhance the probability that any analyte originally present in the sample matrix will not degrade or alter in concentration, and that contaminants that might interfere with the analysis have not been added. For low level (ambient) mercury work, only rigorously acid-cleaned Teflon® containers (or Borosilicate glass or quartz containers with Teflon® lids) may be used for water, as outlined in Table 4.1.

Tissues, sediments, and contaminated water samples should be stored in acid-cleaned glass containers with Teflon® lids. The client is responsible for potential sample contamination resulting from the use of polyethylene, polypropylene, or other plastics not approved for mercury work. Aqueous samples are sent unpreserved by overnight courier, while solid samples are preserved by freezing in the field unless specifically requested otherwise. Each sample container is sealed inside a zip-loc bag which is labeled with a unique sample number and geochemically relevant information (location, depth, date, etc.). After the samples are logged in, rinsed and dried, the sample custodian transports them to the refrigerator, freezer, or shelf space designed and allocated for sample storage. All company employees have access to the sample storage area, which is within the (locked) analytical laboratory.

Summary of Containers and Preservatives
Table 4.1

(G=Glass with Teflon® Lids, T=Teflon® , P = Polyethylene, GT=Gold Trap, CT=Carbotrap, IC=Iodated Carbon, KCL/Lime=KCL/soda lime, IX=Ion Exchange Membrane, QFF=Quartz Fiber Filter).

Parameter	Min. Vol.	Container	Preservative	Hold Time**
Tissues, Sediments				
All Metals	1 g	G,T	Freeze	1 year
Water				
[a]Total Hg	100 mL	T	0.5% HCl	28 days
Se IV and VI	100 mL	G	0.5% HCl	3 months
Non-Hg Metals	200 mL	T,G,P	0.1% HNO_3	6 months
Methyl Hg	50 mL	T	0.5% HCl	6 months
Dimethyl Hg	500 mL	G	1°C, Dark	48 hours
Elemental Hg	500 mL	G	1°C, Dark	48 hours
As(III)/As(V)	200 mL	P	-196°C Freeze*	3 months
Dissolved/Particulate	250 mL	T	1°C, Dark	48 hours
Air				
Total Hg	10 L	G,T	none	6 months
Methyl Hg	10 L	CT	1°C, Dark	7 days
Dimethyl Hg	10 L	CT	1°C, Dark	48 hours
Gaseous Hg (II)	10 m^3	IX	20°C, Dark	7 days
Particle Hg	10 m^3		20°C, Dark	7 days
Flue Gas				
Total Hg/Hg^o	15 L	IC	none	30 days
Methyl Hg	60	KCL/Lime	none	30 days
Ionic Hg	15 L	KCL/Lime	none	30 days

**Holding times are as specified unless previous approval is given by the client. This approval may be in written or verbal form.

[a]Also good for all other trace metals.

*If freezing is not possible, then 0.5% HCl, 1°C, dark.

NOTE: Samples may <u>not</u> be packed in vermiculite, as the dust from this material represents a contamination risk. The client should use bubble wrap or foam as packing materials. All samples known or suspected to contain high mercury levels, or any other hazardous

constituents, must be so identified. Failure to do so may result in additional costs and the return of the samples, as well as liability for damages or injuries which result.

4.1.4 Chain of Custody for Samples in the Laboratory

A sample is considered to be "in custody" if it meets the following criteria:

a) It is actually in the analyst's possession.
b) It remains in the analyst's visual range once possession of the sample has been assumed.
c) The analyst has locked or sealed the sample to prevent tampering.
d) The sample has been stored in a secure area.

To satisfy these custody provisions, the laboratory implements the following procedures:

1. Samples are stored in a secure area.
2. Outside laboratory doors are locked at all times.
3. Visitors are accompanied by a laboratory staff member.
4. Samples remain in the secure area until acceptance of the final report by the client.

Aside from signed and dated records of activities in the lab note books, bench sheets, and sample prep logs, no additional internal chain of custody documentation is maintained.

4.1.5 Sample and Waste Disposal

Samples must eventually be disposed of to preserve laboratory storage space. Proper disposal is emphasized for the sake of efficiency, and, in the case of hazardous substances, safety. On litigation level QA projects, samples are stored for 30 days following submission of the final report unless the client requests otherwise. For levels 2 QA and below, samples may be disposed of immediately following data review, with permission of the group leader or lab manager. Disposal is notated on the sample chain-of-custody form. (Please see Frontier's Hazardous Materials Management Plan for detailed information on hazardous waste disposal.) **Frontier will not accept hazardous samples without prior agreement that the client is responsible for sample handling and disposal after the analytical report has been provided. Exceptions may be made if prior arrangements are approved by the lab manager and the health and safety officer. Frontier reserves the right to reject any samples that may pose a reasonable threat to the health or safety of personnel (for example, unsterilized human biological tissue, radioactive materials, unknown industrial wastes, etc.)**

Section 4.2
Frontier Geosciences' Analytical Procedures

The analytical procedures used at Frontier (Table 4.2) are derived from peer-reviewed literature representing state-of-the-art methods, and are thoroughly tested prior to adoption as Frontier SOP'Ss. The analytical methods used are generally not EPA approved techniques, as Frontier methods operate with lower detection limits, more wide-ranging chemical speciation, and/or greater precision than currently approved EPA techniques.

Recently, however, the method used for total Hg in water (FGS-011) has been given interim approval by the US EPA as Method 1631, and the method used for ultra-clean sampling (FGS-007) as Method 1669. Frontier has been commissioned by the EPA to write more methods in the 1600 series, relating to ultra-clean techniques. When conducting direct injection graphite furnace AAS, Frontier closely follows EPA protocols (Method 200.1). Our method for total arsenic by hydride generation (FGS-022) is functionally equivalent to EPA Method 1632.

Frontier's methods are periodically reviewed and updated to represent the latest thinking of the research community and/or to improve the economics of performing the analyses. Before new procedures are implemented, the analyst conducts the analysis at least three times using standards, spikes, and duplicates in order to establish reproducibility. Once the procedure is properly understood by the analyst, high quality data has been achieved, and it is approved by the lab manager, a standard operating procedure (SOP) is written for the method.

SOP's are given a numerical number that is sequential to the other SOP's. All SOP's are given an SOP number and revision or creation date. The QA officer is responsible for assigning the SOP number and then making sure that the new SOP is followed by laboratory staff. The QA officer is also responsible for checking the document management file and sending out the new version to all applicable persons.

On a yearly basis, new SOP's and versions of SOP's will be compiled and made into an SOP appendix or new SOP manual, depending on how many revisions and newly created SOP's there are.

Literature and SOP References to Analytical Procedures

Table 4.2

Parameter	Frontier SOP	Literature Reference
Total Hg	FGS-009 FGS-011 FGS-012	Bloom, 1993 Bloom & Crecelius, 1987 Bloom & Crecelius, 1983 Fitzgerald & Gill, 1979 US EPA Method 1631
Methyl Hg	FGS-010 FGS-013 FGS-017 FGS-018	Liang, Horvat, and Bloom, 1994 Horvat, Bloom, and Liang, 1993 Bloom, 1989 Bloom and Fitzgerald, 1987
Labile Hg(II), MMHg	FGS-034	Bloom, 1994
Flue Gas Hg	FGS-023 FGS-024 FGS-031	Prestbo and Bloom, 1995 Bloom, 1993
Ultra-Clean Sampling	FGS-007 FGS-008	Bloom, 1995 Fitzgerald and Watras, 1989 Gill and Fitzgerald, 1987 Patterson and Settle, 1977 Bothner and Robertson, 1975 US EPA Method 1669
Ultra-Clean Filtration	FGS-029	Bloom, 1995 Bloom and Effler, 1990
Selenium Speciation	FGS-037	Cutter, et. al, 1986
Arsenic Speciation	FGS-022	Crecelius, et. al, 1986 US EPA Method 1632
Trace metals by GFAAS	FGS-020 FGS-021 FGS-032	Slavin, 1984, US EPA 200.1 Bloom and Crecelius, 1984

Section 4.3
Frontier Geosciences' Calibration Procedures

4.3.1 Standards and Instrument Calibration

Every instrument used to analyze samples at Frontier must pass the calibration criteria established in the appropriate operating procedure document. Initial calibration criteria for instrument reproducibility and sensitivity must be met before samples may be analyzed. Continuing calibration checks establish whether ongoing instrument calibration is acceptable or not. Detailed presentations of Frontier's analytical instrument calibration procedures are provided in SOP's FGS-001 and FGS-020.

All calibration standards are obtained from chemical suppliers and are of high purity and concentration. The standards are routinely checked by the laboratory for traceability to National Research Council of Canada (NRCC) or National Institute of Standards and Technology (NIST) Standard Reference Materials (SRM's). Solutions are normally labeled as follows: name of solution, concentration of solution, date prepared, analyst's initials, and expiration date (if needed). A certificate attesting to the concentration ranges of the covered analytes is maintained in a central Frontier file, entitled "Standard Certificates."

4.3.2 Periodic Calibration Procedures for Other Laboratory Equipment

Periodic calibrations are performed for associated equipment that are required in analytical methods but are not routinely calibrated as part of the analytical procedure. Such equipment includes balances (daily, FGS-002), pipettes (prior to first daily use, FGS-003), ovens (when in use), refrigerators and freezers (daily, FGS-004), and the water purification system (daily). All calibration measurements are recorded in laboratory logbooks.

4.3.3 Supplies, Reagents, Water

All supplies (e.g., glassware, chemicals, reagents, etc.) are of the best possible quality to ensure proper instrument calibration and to avoid contamination. All reagents used are prepared from analytical reagent grade chemicals or higher purity grades, unless such purity is not available. Reagent (18 meg W) water is prepared at Frontier by double deionization of filtered tap water. Each reagent is clearly labeled with the composition, concentration, date prepared, initials of preparer, and expiration date, if necessary. Reagents that have a long, unquantified shelf life, and standards, which are re-calibrated monthly, are not given expiration dates.

Reagent solutions are stored in appropriate glass or plastic containers, under conditions designed to maintain their integrity (refrigerated, dark, etc.). Reagent solutions are checked for contamination before use in any analysis. If known to be finite, shelf life is listed on the label. Expired reagents are appropriately discarded. To avoid chemical waste and excess pollution, chemicals and standards with no known storage shelf life are kept indefinitely, except at specific contractor request. All acids for trace metal analysis other than mercury are either glass-distilled or of special grade for trace metals analysis.

Laboratory water is double deionized and checked at least weekly for mercury concentration. Our goal is to maintain [Hg] at less than 0.2 ng/L and MMHg at less than 0.01 ng/L. In the event that concentrations are observed above 1.0 ng/L for total Hg and 0.025 ng/L for MMHg, all low level analysis is discontinued until the problem is identified and remediated.

The laboratory air is monitored for mercury on a monthly basis, both in the clean room and in general laboratory space. The quality maintenance standard levels for the clean room and laboratory air are 5 and 10 ng/m^3 respectively, with corresponding action levels of 15 and 30 ng/m.

Acid-cleaned sample bottles are stored with 0.5% HCl for Hg, As, and Se, and 0.5% HNO_3 for other trace metals. At least six bottles per week are randomly selected and the acidified water contents checked for mercury (EPA 1631) or trace metals scan by ICP-MS. Control charts will be kept of these data points for the following metals: Hg, As, Se, Zn, Cu, Pb, Cd, Ni, Fe. The occurrence of contamination (Hg > 1 ng/L, all others > 0.5 µg/L) must be maintained with a running frequency of less than 3% of bottles tested. Each new lot of EPA-clean ("I-CHEM") bottles of each size will be tested for Hg by filling with 0.5% BrCl in distilled water. These values will be logged. Any lot found to contain blanks of > 1 ng/L will not be used for low-level work.

Section 4.4
Data Precision and Accuracy

4.4.1 Calibration Checks

Calibration check samples are used to verify the standard calibration curve. At least one check sample is analyzed with each batch of samples at the beginning of each calibration period. Calibration check samples can either be prepared in the laboratory (additional standards) or are available as Standard Reference Materials (SRM's) from the NRCC or NIST. Performance Evaluation samples serve as an accuracy check of laboratory operations and measurement systems by comparing results with those of other laboratories. The experimental results of the check sample are compared with the true values, and the percent recovery of the check standard is calculated. If the percent recovery falls within the acceptance range, then sample analysis proceeds. However, if the percent recovery does not fall within the acceptance range, the sample is run again, and if it still does not fall within the acceptance range, the problem is identified, corrected, and the instrument calibration sequence begins again.

SRM data is maintained chronologically in a computer database, and control charts are examined on a weekly basis to assess long-term laboratory performance trends. The control chart is used to assess trends, and therefore a single deviant point will not be considered evidence that an analytical procedure is out-of-control. If, however, two or more points in any five day period are found to be more than three sigma away from the long-term mean for that parameter, the analytical procedure will be considered out-of-control, and all analyses halted until the problem is identified, corrected, and a triplicate analysis of that parameter is found to be in control. In cases where two or more QC points are found to deviate by between two and three sigma over a five day period, the system will be considered under probation, and additional QC

checks will be performed. If, over another five day period, performance continues to give results greater than two sigma from the mean, the system will be considered out-of-control. In all cases where >95% of all QC measurements over a given period for a method are within two sigma of the long-term mean (or certified range, whichever is smaller), then the system shall be considered in control.

Data collected from inter-laboratory intercomparisons and performance evaluation (PE) samples are maintained by the QA officer. In the event that a result from such a sample deviates from the acceptance or group mean interval reported, the source of the discrepancy will be located, and corrective action will be taken. Aliquots of all PE and intercomparison samples will be retained until the group results are reported so that the samples may be re-run if necessary.

4.4.2 Matrix Spike/Duplicate Spike Analysis

For litigation level QA work, and any new sample matrix/analyte combination, one in every twenty samples will be analyzed with a matrix spike and matrix spike duplicate. In this type of analysis, predetermined quantities of stock analyte are added to a sample matrix prior to sample extraction or digestion and subsequent analysis. Because the nature of such digest is well understood in the case of simple total metals digestions, the matrix spike can be added to the digest after digestion, but prior to dilution, unless specifically disallowed by contract language. This procedure allows initial analysis of samples to calculate appropriate spiking levels.

Percent recovery is calculated for the amount of added analyte detected. Spike recoveries of 75-125% (70-130% for MMHg) are considered acceptable. The relative percent difference between the samples is calculated and used to assess analytical precision (see Duplicate Samples, Section 4.4.4). The concentration of the spike should be 2-5 times the expected concentration of the analyte in the unspiked media. In general, this means that MS/MSD analyses will be performed after the unspiked samples are analyzed, and the concentrations calculated.

For levels of QA other than litigation, the client or project manager will specify spiking frequency.

4.4.3 Duplicate Samples

Duplicate samples provide information about sampling plus analysis precision and accuracy. Duplicate samples may be either true duplicates or split samples. True duplicates are two samples collected from a common sampling location in two independent sampling events. Ideally, these samples should have identical compositions, although in fact, a degree of field variability always contributes to the observed difference between duplicates. Split samples are one or more sub-samples of a homogeneous sample. These samples should be identical in concentration, and are a direct indicator of analytical-only precision. However, in the cases of unhomogenizable samples, such as Hg^0 contaminated soils, splits will be considered as functionally equivalent to field duplicates. The frequency of duplicate sample collection and analysis is specified in the contract with the client. Typically, one duplicate or split sample is performed per twenty samples collected, or one per sampling event, whichever is more frequent. The

relative percent difference (RPD) between the two values is calculated as 2*(R1-R2)/(R1+R2). The RPD for sample splits must be <25% at concentrations greater than 10 times the MDL to be considered in control. The laboratory has no control over field and sampling induced variability, and so the relative precision of field duplicates may be viewed as serving informational purposes only.

Section 4.5
Frontier Geosciences' Quality Control Checks

4.5.1 QC Samples

The laboratory uses QC samples to assess validity of the analytical results of field samples. QC samples include method blanks, calibration checks, performance evaluations, duplicates, and spiked samples. QC samples are analyzed in the same manner as field samples, at a frequency described either in the individual procedures, or in the contract with the client. If the QC sample results fall within the acceptance criteria (also detailed in the method or prescribed by the client), then the field sample data is considered to be valid or acceptable as-is. Unless specified otherwise by the client, the acceptance criterion for data based on QC samples is specified in the SOP on Calibration Procedures (FGS-001), and in Table 4.3. These criteria are followed per set for litigation level QA and per day for research level QA. Of particular importance to the client is Frontier's position that a **single non-compliant result on a QC sample does not automatically invalidate a data set**. If the other QA data in the same data set is of acceptable quality, and a re-run of the out-of-control sample is also of acceptable quality, then the entire data set is considered to be in control and acceptable.

4.5.2 Method Blanks

A method blank is a sample of reagent water or analytical reagents that undergoes the same analytical process as the corresponding field samples. Method blanks are used to monitor laboratory performance as well as to detect contamination that could have been introduced during the analytical procedure. For litigation level work, a minimum of three method blanks are required per batch, or one per ten samples, whichever is higher. For research level QA, the number of blanks required is determined by the project manager based upon historical information on blank values for the same analytical method, and the expected concentrations in the samples. All Frontier results will be reported as corrected for the mean of the method blanks analyzed with the samples, unless previously specified by the contract language.

4.5.3 Certified Reference Materials (CRM's)

Frontier maintains the position that matrix equivalent CRM's are the best measure of precision and accuracy, as problems associated with homogeneity and spikes not matching the true analyte forms are avoided. Unfortunately, CRM's do not exist for all matrices. Frontier will utilize CRM's at a rate of 1 per

20 samples or 1 per set, whichever is greater, whenever the appropriate matrix is available (sediments, tissues, sewage sludge, sea water).

4.5.4 Interlaboratory Intercomparisons

For matrices where no CRM's are available at ambient levels, Frontier will endeavor to participate in at least one interlaboratory intercomparison or round robin per year. These include low level speciation of Hg, As, and Se in water. In addition, Frontier routinely participates in several interlaboratory intercomparisons per year, including the EPA's WP series, APG, and USGS.

Litigation Level
QC Requirements for Data Validation
Table 4.3

QC Requirement	Minimum Frequency	Limits
all standards, force through zero	min. 4 points/day	r > 0.995
continuing calibration	1 per 10 samples	80-120% of initial slope
laboratory duplicate	1 per 20 samples	± 25% RPD @ > 10xMDL a
method blanks[a]	3 per batch or 1 per 10 samples, whichever is greater	a
Standard Reference Material	1 per dataset	a
matrix digestion MS/MSD	1 per 20 samples	75-125% Rec. a
ongoing precision and recovery	as stipulated by contract language	
low-level spike recovery	as stipulated by contract language	
filtration blanks	as stipulated by project manager	

[a]Numeric values in corresponding SOPs

Section 4.6
Data Reduction, Review, and Verification

After the data has been acquired, and any necessary calculations performed, the initial review is performed by the analyst. Items included in the review include: sample identity, peak height verification, instrument calibration, QC samples, detection limits, numerical computations, accuracy of transcriptions, and compliance with the individual method. For research level QA projects, this is the full extent of the formal data review. Screening level data verification is dependent upon the project, but is generally less stringent than research level data verification.

On litigation level QA projects, following the analyst's review, the QA officer or his/her designate reviews 100% of the raw data, the analyst's chemical interpretation and any out-of-control conditions that may be identified by the analyst (FGS-038). Additionally, the QA officer examines the QC sample data and ensures that the analytical results are within Frontier-prescribed criteria for accuracy and precision. Finally, as specified by the client, the data may be further reviewed by the client, or by an independent data validator.

Data verification is part of the review process whereby data is inspected and either accepted or rejected based on a set of criteria. Evaluation parameters that can be used for validation include, but are not limited to the following:

a) Performance on SRM's (precision and accuracy)
b) Calibration data
c) Specific checks unique to each measurement

Section 4.7
Data Reporting

Data is reported using a format specified in the client's contract. Data is generally reported via US Mail or 2nd day Fed-Ex in tabular form with a case narrative and/or cover letter attached. All of the data, including standard spike recoveries, control samples, duplicate analyses, and results from blank analyses, is reported along with the sample results in the calculation spreadsheets. Samples re-run for reasons of analytical error (i.e. spiked incorrectly, pipetting error, aliquot too large or too small, gas flow problem, etc.) will not be addressed in the sample report. Samples with results that are unaccountable to physical, laboratory problems, will be addressed in the sample report. All requests for sample re-runs for litigation level work must come within 30 days of report submittal. The detection limits of an analytical procedure are reported if the analyzed value is less than the detection limit. Footnotes are referenced to specific data if an explanation of reported values is required. All the reports are signed and transmitted by the project manager or designee. If previously negotiated, data may be transmitted via electronic media (diskette, modem, e-mail, fax), and/or in specific formats (i.e., Excel file, ASCII, etc.). Negotiable aspects may include the additional cost of specific computer programs, equipment, or on-line services. Our guaranteed turn-around-time for a summary data report is four weeks from receipt of the last sample in a set, with the full QA report coming no more than two weeks later. Generally a faster response time is achieved (1-2 weeks), especially for research level projects.

QC Documentation Provided with Frontier Data Packages

Table 4.4

Document	Abbreviated Package	Full Package
Chain-of-Custody Form	archived	provided
Analytical Bench Sheets	archived	provided
Sample Prep Logbook	archived	at client request
Raw Data	archived	at client request
Uncorrected results	not provided	provided
Corrected results	provided	provided (unless specified)
QC data	summary	complete
Case narrative	abbreviated	complete
Instrument Logs	not provided	at client request
Reagent Prep Logs	not provided	at client request
Control Chart data	not provided	at client request
Phone/Fax Records	not provided	at client request
Data Interpretation	at client request	at client request

Thank you for your time and effort in reading this document. We at Frontier Geosciences Inc. realize that technical documents are not always the most entertaining papers to read and we are constantly striving to be as succinct and readable as possible. Your comments are most welcome and encouraged. Please feel free to call, fax or email Beverly A. Heaphey, Quality Assurance Officer, with any questions, comments or suggestions.

phone: *(206) 622-6960*
fax: (206) 622-6870

email: bevh@frontier.wa.com

GLOSSARY

Accuracy: Ensures how close the results are to a true or expected value and can be determined by comparing the analysis of a standard or reference sample to its actual value.

Aliquot: A measured portion of a sample taken for analysis. One or more aliquots make up a sample.

Blind Sample: A type of sample used for quality control purposes, a blind sample is a sample submitted to an analyst without their knowledge of its identity or composition. Blind samples are used to test the laboratory's expertise in performing the sample analysis.

CLP: The EPA's Contract Laboratory Program. The CLP provides analytical services to the 10 EPA Regions through contracted commercial laboratories.

Comparability: The extent to which data can be compared between sample locations or periods of time within a project, or between projects.

Completeness: The comparison between the amount of valid data originally planned to be collected, versus how much was collected.

Concentration: Defined as high, medium, or low, and used to determine how much volume is collected or the analytical protocol to be followed.

Data quality objectives (DQOs): Quantitative and qualitative statements describing the degree of the data's acceptability to the data user(s). They include indicators such as accuracy, precision, representativeness, comparability, and completeness. DQO's specify the quality of the data needed in order to meet the project's goals. The planning process for ensuring environmental data are of the type, quality, and quantity needed for decision making is called the *DQO process.*

Data turnaround time: The maximum length of time allowed for laboratories to submit analytical data to EPA in order to avoid liquidated damages. Data turnaround time begins at the validated time of sample receipt (VTSR) at the laboratory.

Detection limit: Applied to both methods and equipment, the lowest concentration of a target analyte that a given method or piece of equipment can reliably ascertain and report as greater than zero.

Duplicate sample: Used for quality control, two samples taken at the same time from, and representative of, the same site that are carried through all assessment and analytical procedures in an identical manner. Duplicate samples are used to measure natural variability as well as the
precision of a method, monitor, and/or analyst. More than two duplicate samples are

referred to as *replicate samples.*

Equipment or rinsate blank: Used for quality control, types of field blanks used to check specifically for carryover contamination from reuse of the same sampling equipment (see *field blank).*

Field blank: Used for quality control, a field blank is a "clean" sample (e.g., distilled water) that is otherwise treated the same as other samples taken from the field. Field blanks are submitted to the analyst along with all other samples and are used to detect any contaminants that may be introduced during sample collection, storage, analysis, and transport.

Fraction: A specific subunit of an analytical protocol. For example, for low/medium organics, the fractions are volatiles, semivolatiles, and pesticides/Aroclors.

Instrument detection limit: The lowest concentration of a given substance or analyte that can be reliably detected by analytical equipment or instruments (see also *detection limit).*

Matrix: A matrix is a specific type of medium, such as water, soil, or sediment, in which the analyte of interest may be contained.

Method detection limit (MDL): The MDL is the lowest concentration of a given substance or analyte that can be reliably detected by an analytical procedure (see detection *limit).*

Precision: The degree of agreement among repeated measurements of the same characteristic. It may be determined by calculating the standard deviation, or relative percent difference, among samples taken from the same place at the same time.

Preservative: A chemical added to inorganic and volatile water samples to maintain the integrity of the sample. Some common preservatives include nitric acid, hydrochloric acid, and sodium hydroxide.

Quality Assurance (QA): Refers to the overall *management system* which includes the organization, planning, data collection, quality control, documentation, evaluation, and reporting activities of a particular project. QA is designed to ensure that a product or service meets defined standards of quality with a stated level of confidence. -

Quality Assurance Project Plan (QAPP): A formal written document describing the detailed *quality control* procedures that will be used to achieve a specific project's data quality requirements.

Quality Control (QC): Refers to the routine *technical activities* designed to measure quality and limit error in a product or service. Since errors can occur in either the field, the

laboratory, or the office, QC must be part of each of these functions.

Quality Control (QC) Samples: Samples used to estimate the precision and accuracy of analytical results in the field and in the laboratory.

Representativeness: The extent to which measurements actually represent the true environmental condition or population at the time a sample was collected.

Sample: A single, discrete portion of the environment collected from a specified physical location at a specific time. The single sample may be placed in multiple vessels.

Sample container: The individual bottle that contains the sample or an aliquot of the sample. The type of sample container varies for different sample fractions and concentrations.

Sample custody: Legal possession of and responsibility for a sample. Documentation of sample custody is maintained on the chain-of-custody part of the traffic report or packing list. The sample is in your custody if any of the following criteria are met: 1) the sample is in your possession or is in your view after being in your possession, 2) the sample was in your possession and then locked up or sealed to prevent tampering, or 3) you have placed the sample in a secured area.

Sample label: Taped or adhesive labels that provide the sample numbers to be assigned to the samples.

Sample number: The sample number from the sample label that identifies the sample or an aliquot of the sample.

Spiked samples: Used for quality control, a sample to which a known concentration of the target analyte has been added. When analyzed, the difference between an environmental sample and the analyte's concentration in a spiked sample should be equivalent to the amount added to the spiked sample.

Split sample: Used for quality control, a split sample is one that has been equally divided into two or more subsamples. Splits are submitted to different analysts or laboratories and are used to measure the precision of the analytical methods.

Standard deviation(s): Used in the determination of *precision,* the most common calculation used to measure the range of variation among repeated measurements. The standard deviation of a set of measurements is expressed by the positive square root of the variance of the measurements.